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T H E S I S

THE STRESS-DEFORMATION PROPERTIES OF COMPACTED CLAY SOILS

Submitted as a Partial Fulfillment

of the

Requirements for the Degree of

Master of Science

by

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Under the direction of

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April 12, 1947

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UNIVERSITY OF ALBERTA

FACULTY OF APPLIED SCIENCE

This is to certify that the undersigned have read and recommended to the Committee on Graduate Studies for acceptance, a thesis submitted by Richard H. Hislop, B.Sc. entitled:

THE STRESS-DEFORMATION PROPERTIES

OF COMPACTED CLAY SOILS

Professor

Professor

Professor

I N D E X

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INTRODUCTION

In any construction project, the engineer is concerned with the properties of the soil with which he is dealing, either as a foundation or as a material of construction. This science has been loosely grouped under the title of "Soil Mechanics" and deals with the study of the subsoil from an engineering rather than a geological or agricultural point of view.

The study of soil mechanics may be divided into two phases - stability and elasticity problems. Classification tests have been developed by which the behavior of soils under actual conditions can be predicted in the laboratory with reasonable accuracy. Suitability of a given soil for various construction purposes may be determined, and soil not suitable in its natural state may be made suitable by the addition or subtraction of other materials, as determined by soil tests. These are referred to as stability problems.

Elasticity problems deal with the deformation and possible failure of the soil due to a combination of its own weight and externally applied loads. In this case, the tests developed are not as concise and their results are more difficult to interpret. This is especially true in the case of clay soils. The fine nature of the particles reduces their permeability. When a load is applied to a saturated clay soil it is taken initially by the water body, setting up a hydrostatic excess pressure. This load is then gradually transmitted to the soil skeleton as the water is forced out. Thus an additional variable is introduced.

The prairie regions are largely overlain by glacial till deposited by the Keewatin glaciers, or in the western area by the Rocky Mountain glaciers. A study of the stress-deformation properties of these clays would be of value to the engineer in connection with any construction project in these regions.

When dealing with earth fills, the moisture content of the soil is a critical factor, both from the point of view of ease of compaction and resulting stability. By stability is meant the susceptibility of the soil to frost heave or swelling, and its strength, or ability to withstand pressures resulting, usually, from rapidly applied loads. If soils are loaded excessively, failure takes place. Soils are thought to fail by shear, followed by plastic flow to the sides, with resulting deformation. From the point of view of airfield or highway construction a subgrade is considered to have failed if the deflection is large enough to fracture the surfacing material.

The influence of the moisture content on the compressive strength (and consequently on the shearing strength) and deformation properties of typical prairie clays may be logically predicted within limits, but a certain amount of experimental investigation would appear advisable.

To carry out such an investigation, representative soil samples would be obtained, subjected to laboratory tests reproducing field conditions as closely as possible, and stressed to failure. In this way some idea of their probable actual behavior in place could be obtained, and the effect of the moisture content could be observed.

This in fact has been done for a set of soil samples taken from the sub-grades of the Lethbridge and Regina airfields. A description of the tests and their results is presented here.

The subject is dealt with under the following headings - Description and Characteristics of the Soil Samples, Preparation and Testing, Description of the Equipment Used, Observed and Computed Data (with accompanying graphs), Summary of Results, - and a discussion of the theoretical basis of the tests and the resulting conclusions.

This paper is the result of a program of investigation carried out at the University of Alberta under the direction of Professor R.M. Hardy,

Dean of the Faculty of Applied Science. In brief, the object of the work was to investigate and explain the stress-deformation properties of compacted clay soils common to the prairie regions.

GENERAL DESCRIPTION OF THE SOIL SAMPLES

Soil Samples were obtained from the sub-grade at five different locations on both the Lethbridge and Regina airfields - making ten samples in all. Each of these samples was air dried, passed through a number 4 sieve and thoroughly mixed.

The system of numbering might well be explained here. The first two letters of the code number indicate the airfield - CL for Lethbridge, CR for Regina; the group 6U, 8U, 103U, etc. indicates the location from which the sample was obtained; the letters "SG" distinguish sub-grade from base course samples; the final group 0-6, 6-12, 12-18 indicates the depth below the surface from which the samples were obtained - thus 0-6 refers to a depth of 0 to 6 inches below the surface, - 6-12, from 6 to 12 inches and 12-18 from 12 to 18 inches below the surface.

The general characteristics of these soils are tabulated on the following sheets according to various classification tests.

As a point of interest, an attempt has been made to trace the geological origin of the clays found on the sites of the two airfields. The following information was obtained from the "Geological Survey of Canada Memoirs" and from a pamphlet published by the Research Council of Alberta.

LETHBRIDGE - "Much of the area in the Lethbridge sheet is veneered with glacial deposits left when the ice sheets melted. Glaciation was general over most of the area and the rock debris carried in and on the glaciers was strewn about as deposits of irregular thickness after the ice sheets retreated.

Airport LETHBRIDGE

Code Number	QL 100U SG 612	QL 101U SG 1218	QL 102U SG 1218	QL 103U SG 1218	QL 104U SG 1218
Runway	150' apron	NW-SW taxi	NE-SW	N-S taxi	E-W
Station	1 + 08.5	5 + 25	8 + 50	6 + 00	20 + 00
Offset	82.4	22	76	25	75
Liquid Limit	33.7	49.3	29.7	27.3	34.7
Plastic Limit	21.5	25.4	16.0	16.1	18.4
Plasticity Index	12.2	23.9	13.7	11.2	16.3
Flow Index	8.9	20.1	7.2	12.9	7.1
Shrinkage Limit	16.30	12.20	13.20	15.31	14.29
Shrinkage Ratio	1.81	1.91	1.90	1.84	1.86
Specific Gravity	2.74	2.76	2.74	2.64	2.69
Optimum Moist. Cont. % dry weight	14.8	20.0	11.3	11.6	11.6
Max. Dry Density #/cu.ft.	113.2	103.7	119.6	118.8	116.0
CBR Undisturbed	--	8.3	9.2	13.5	14.2
CBR Soaked	--	6.8	3.7	2.3	5.0
Compressive Index	--	0.195	0.276	0.214	0.205
Swelling Pressure #/sq.in.	--	7.4	4.8	3.8	3.4
% Coarse Sand (Larger than 0.42 mm)	1.0	3.6	8.1	6.0	5.1
% Medium Sand (0.42 mm to 0.149 mm)	6.4	14.7	17.6	15.4	14.7
% Fine Sand (0.149 mm to 0.074 mm)	20.3	9.6	12.1	15.0	13.1
% Very Fine Sand (0.074 mm to 0.060 mm)	28.7	27.3	17.4	25.3	30.5
% Silt (0.060 mm to 0.003 mm)	34.9	32.0	39.0	37.5	34.9
% Clay (Finer than 0.003mm)	8.7	12.8	5.8	0 .3	1.7

Airport REGINA

Code Number	QR 3U SG 06	QR 5U SG 06	QR 6U SG 06	QR 7U SG 06	QR 8U SG 06
Runway	25 - 7	21 - 3	21 - 3	12 - 30	12 - 30
Station	25 + 25	16 + 19	24 + 00	3 + 40	18 + 18
Offset	75	75	75	75	75
Datum	N. Edge	N.W.Edge	N.W.Edge	N.E. Edge	N.E.Edge
Liquid Limit	78.0	64.0	79.0	73.1	76.8
Plastic Limit	34.6	33.4	38.6	38.7	42.0
Plasticity Index	43.4	30.6	40.4	34.4	34.8
Flow Index	18.7	12.9	16.5	20.5	13.0
Shrinkage Limit	6.60	8.11	8.85	11.77	11.39
Shrinkage Ratio	1.98	1.96	1.96	1.81	1.89
Specific Gravity	2.66	2.69	2.68	2.67	2.63
Optimum Moist. Cont. % dry weight	25.6	24.4	22.0	26.8	21.5
Max. Dry Density #/cu.ft.	92.5	93.3	92.0	92.7	94.3
CBR Undisturbed	6.1	5.8	9.6	5.7	6.4
CBR Soaked	6.8	3.5	4.7	1.7	5.0
Compressive Index	0.238	0.340	0.223	0.567	0.244
Swelling Pressure P.S.I.	12.7	10.0	22.0	3.3	11.0
%Coarse Sand (Larger than 0.42 mm)	6.5	0.7	10.7	5.4	21.5
% Medium Sand (0.42 mm to 0.149 mm)	4.5	1.5	2.4	0.7	0.4
% Fine Sand (0.149 mm to 0.074 mm)	65.3	19.9	18.8	15.0	13.8
%Silt(0.060 mm to 0.003 mm)	20.4	38.2	36.9	37.6	38.9
% Clay(Finer than 0.003 mm)	0.4	36.6	28.3	39.4	25.3

"There is also a widespread distribution of reworked glacial till, as well as alluvial and lacustrine deposits transported by rivers and numerous small drainage systems.

"The glacial deposits have been derived from one of two sources. The mountain glaciers originated in the Rocky Mountains and proceeded eastward over the foothills and plains carrying rock debris from the formations within, or possibly to the east of the front ranges of the Rocky Mountains. The Keewatin or Continental glaciers originated in the vicinity of Hudsons Bay, bringing with them a very different kind of rock debris, derived from the Pre-Cambrian rocks in the Canadian Shield and including rock material from the plains over which the glaciers passed.

"The morainal material transported from the mountains consists largely of limestone, shale, slate and quartzitic sandstone, or volcanic rock such as that derived from the Crowsnest volcanics in the vicinity of Coleman.

"The detrital material transported from the northeast by the Keewatin glaciers consists largely of igneous rocks such as granite, gabbro, gneiss, greenstone etc., and locally, of harder sandstone from the younger rock formations under the plains over which the ice moved."

From an examination of the gravel screened from the Lethbridge samples, it might be concluded that this soil was deposited by the aforementioned Rocky Mountain glaciers. - It is characterized by large amounts of lime carbonate at or near the surface and extending throughout the profile.

REGINA - "Except for two areas of little or no drift, Saskatchewan is mantled by a thick deposit of glacial drift. It is more than 495 feet thick at one locality 25 miles east of Regina.

"In Southern Saskatchewan, north and east of the Missouri Coteau,

there are at least three till sheets, the oldest of which presumably is the Kansan, the middle one the Iowan or early Wisconsin and the uppermost the late Wisconsin or the whole of the Wisconsin.

"The final retreat of the ice is marked by moraines, by the flat bottoms of temporary lakes - dammed by the retreating ice, and by dry valleys - once diversion channels which drained the lakes. The Regina plain is an example of the bottom of a glacial lake. The clay consists of well mixed, fine particles of zircon, tourmaline, apatite and larger quantities of feldspathic minerals - chiefly bentonite."

From this analysis we would expect the Regina clay to contain a large amount of very fine clay or colloidal particles and as a result to be highly plastic, and highly impermeable. These assumptions are borne out by the experimental results as shown in the preceding table.

The Lethbridge soil may be classified as a dense sandy clay of average plasticity.

PREPARATION OF THE SAMPLES AND THE TESTING PROCEDURE

In brief, the procedure consisted of performing triaxial tests on samples of the soil, compacted according to the Modified Proctor method at 8 different values of the moisture content for each sample - a total of 80 complete tests on 240 individual cylinders.

The soil to be tested was first oven dried. Approximately 4000 grams dry weight was weighed out and mixed with water to obtain the required moisture content. One per cent was allowed for evaporation. The previously determined optimum moisture content was used as a guide and an attempt was made to compact the soil, first at this optimum moisture content, then at minus 4%, minus 2%, plus 2%, plus 4% and then at 90% of maximum dry density, at 85% and at 80% of maximum dry density.

The soil and water were throughly mixed with a trowel and compacted in two standard Proctor cylinders, in five layers with twenty five blows per layer. The rammer used weighed ten pounds and had an 18" drop. The edges were trimmed and a record kept of the weight of the cylinder and wet soil. A cone bearing test was performed on each cylinder at this point. Two standard brass sampling tubes 1.39 inches in diameter were then forced into each cylinder to obtain four samples for the triaxial test. These were dug out and capped to prevent evaporation, using petrie dishes and melted paraffine. The samples were then cured for from 18 to 24 hours.

The triaxial testing procedure was standard except that air was used as the pressure medium. The equipment itself was similar in design to that used at Harvard except for a modified base pedestal which will be discussed later. The lateral pressures used were 0, 15 and 30 pounds per square inch. The fourth sample was kept as a spare and in the case of uniform breaking loads, was tested at 45 pounds per square inch as a check. The rate of loading was kept constant at 1.02 kilograms per square centimeter per minute. That is, 100 gram loads were added to the scale pan on the minute and half minute and readings of the strain guage were taken at 15 seconds and 45 seconds. At the higher moisture contents, 50 gram increments were added at each quarter minute and the readings taken half way between loadings. Moisture contents were taken immediately after compaction and after the triaxial tests. They were found to remain substantially constant.

The observed data was converted to values of stress in kilograms per square centimeter and strain in % of original length of the sample. The area was corrected by dividing the original area by (1 - Strain).

From these figures the stress-deformation curves and the Mohr's rupture line were plotted for each soil sample. Corresponding values of cohesion c in tons per square foot, and the angle of shearing resistance ϕ in degrees were thus obtained.

EQUIPMENT USED

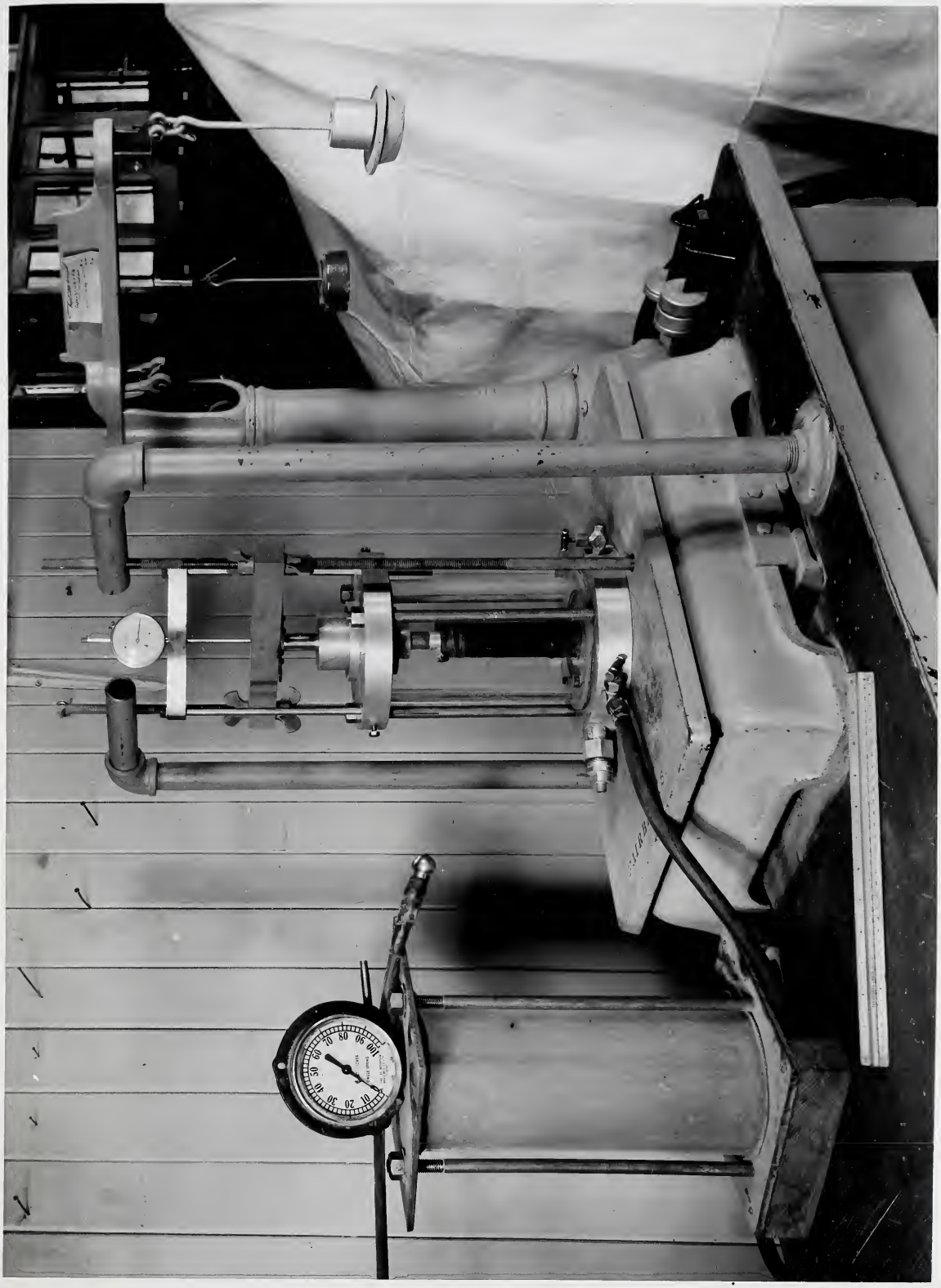
The testing procedure involved the use of equipment from three standard tests. The Modified Proctor test and the Cone Bearing test conformed to the procedure and specifications listed in the American Society for Testing Materials pamphlet "Procedures for Testing Soils" and will not be elaborated upon.

The triaxial equipment used is standard except for a modified base plate and pedestal. A sketch showing the modifications is included here. The change in design permits the pedestal to be removed and replaced with one larger or smaller, to accomodate different sized samples. The joints are all water tight and no leakage was observed at pressures of up to 50 pounds per square inch.

This design varies from that outlined in the "Seventh Progress Report of the Harvard Graduate School of Engineering to the United States Waterways Experiment Station" in that the outlet is brought out to a fitting on the side of the base rather than through the bottom. In addition, porous bronze discs are used in place of the porous stones formerly used to drain the cap and base. This eliminates almost all deflection in the cap and base and drains equally well.

The loading is accomplished by adding weights to the scale pan. This is magnified 50 times by the scale mechanism and is transmitted by means of the scale platform to the base of the apparatus and is opposed by a movable loading yoke resting on the piston head. A strain gauge is

Triaxial Apparatus



mounted on the upper plate of the apparatus and registers any deflection of the piston relative to the head plate.

DISCUSSION OF THE THEORETICAL BASIS OF THE INVESTIGATION

a. CHARACTERISTICS OF WATER FILMS - An appreciable amount of work has been done on the investigation of the nature of the water films surrounding earth particles, and several hypotheses have been advanced - notably by Terzaghi [9a] and Hogentogler. [5] In brief the theorem is this - that each particle in an earth body is surrounded by a film of moisture which may vary in thickness according to the moisture available. The water forming these films increases in viscosity closer to the particle until at the surface of the particle, the water is so viscous as to be considered solid, and actually forms an intergral part of the particle itself. This increasing viscosity is thought to result from the intramolecular attraction between the particle and the water. Naturally, this force would become stronger as the distance of separation decreased and according to Terzaghi the films become semi solid substances at thicknesses less than 2×10^{-6} inches.

Hogentogler assumes the water film to be in four layers, and elaborates on the above hypothesis. In colloidal masses he considers each soil particle to be encased in a film of adsorbed water, and surrounded by free water. (see sketch) Free water has the freezing point, boiling point, surface tension and viscosity of ordinary water. The adsorbed water films have higher boiling points, lower freezing points, greater surface tension and are more viscous.

The outermost layer is most nearly like free water. The innermost layer most nearly like solidified water or ice, due to the intra-molecular attraction or cohesive force. This force has been estimated at over 2000

atmospheres. On this basis Hogentogler states that the films could conceivably be ice since, at the enormous pressures under which they exist, the melting point of ice may be in excess of 76° C. or 168° F. according to the Smithsonian tables.

If soils are dried at high temperatures, these films become more permanent and a chemical reaction occurs making the moisture an integral part of the chemical composition of the particle. In evidence of this, the plastic properties of most clays are entirely destroyed if dried at temperatures exceeding 500° C.

In connection with Proctor's theory of compaction it is known that, for a standard compacting process, the resulting compacted density of the soil in pounds per cubic foot varies with the moisture content, and for any soil there is an "Optimum Moisture Content" resulting in a maximum value of compacted dry density. The usual plot of dry density in pounds per cubic foot, soil moisture content as a % of dry weight, results in a smooth curve for most soils.

Work done at George Washington University has shown that if the dry density in pounds per cubic foot is plotted against the moisture content as a % of the combined volume of soil solids and moisture, the curve becomes a series of straight lines with different slopes. (see sketch)

The relation between the two moisture contents is given by

$$W' = \frac{100\ SW}{SW + 100}$$

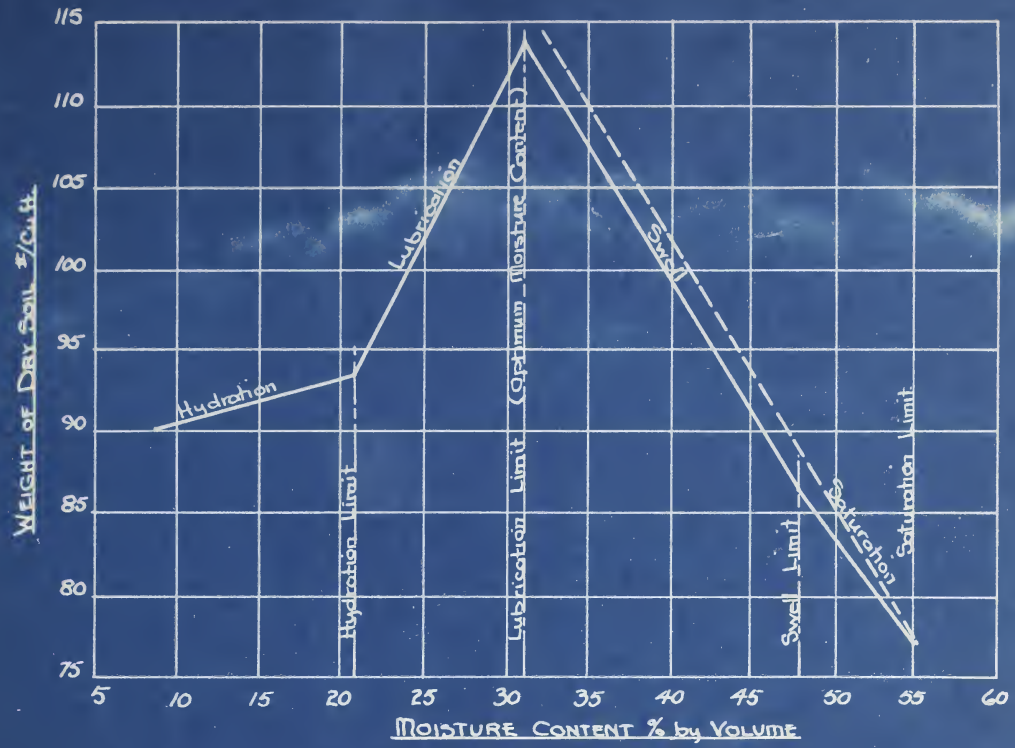
where W' = moist. cont. in % combined wt. of soil & moisture

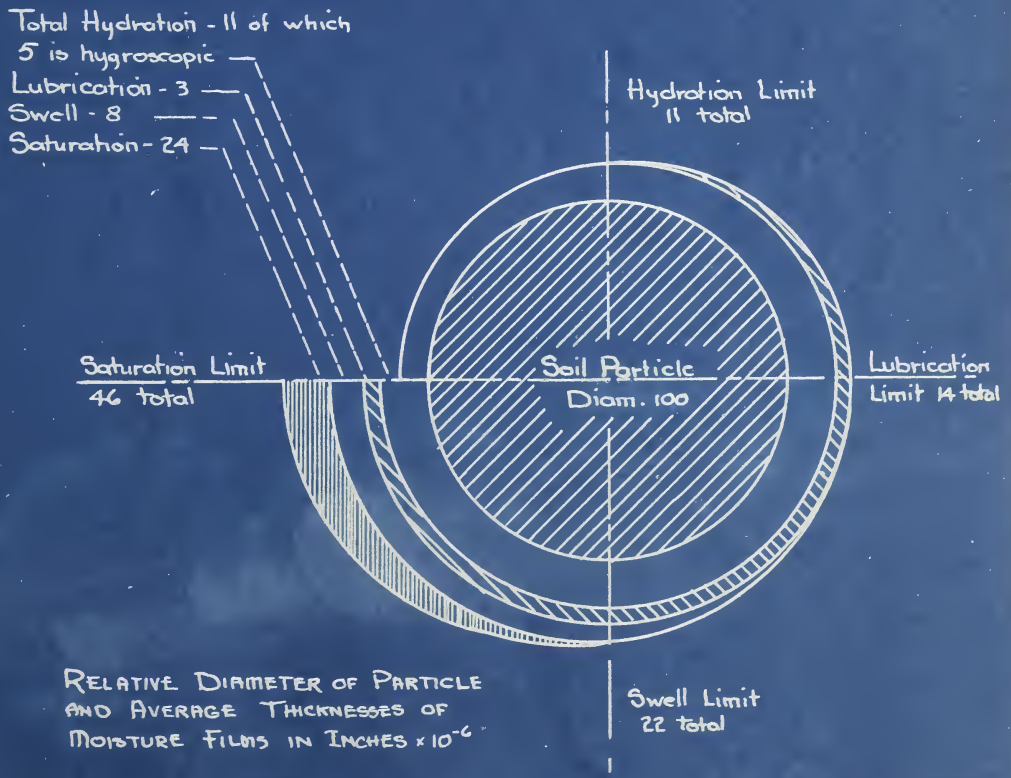
S = specific gravity of soil solids

W = moist. cont. as % of dry weight

Starting with an oven dried sample, the initial wetting may be termed the "stage of hydration". During this stage, part of the water is adsorbed

Relation of Dry Density to Moisture Content as % Volume





Relative Diameter of Particle and Average Thicknesses of Moisture Films in Inches $\times 10^{-6}$

by the soil particles and the remainder adsorbed on their surfaces in the form of cohesive films. The maximum point of this stage has been referred to as the "Hydration Limit".

The next stage is referred to as the "stage of lubrication". Part of the contained moisture now acts as a lubricant to facillitate the rearrangement of the particles being compacted without, however, excluding all the air. The maximum point of this stage of wetting has been referred to as the "Lubrication Limit". It is the "Optimum Moisture Content" at which the maximum density is attained.

Water in excess of the lubrication limit causes the soil mass to swell. This action would account for the swelling pressures exhibited by certain clay soils - notably prairie clays. The amount or intensity of swelling pressure appears to result from the tendency of the particles to develop thicker films. That is - the attraction between the particle and the moisture is evidently stronger than the hydrostatic excess pressure resulting from the swelling, and tending to force the water out, and thus decrease the size of the films. Carrying the deduction further, the grain size distribution, the shape of the particles, and possibly the chemical composition of the particles would influence the potential intensity of the swelling pressure and this, in conjunction with the moisture content of the soil prior to swelling, would determine the amount of swelling to be expected.

The end point of this stage has been termed the "Swell Limit". The air contained in the soil at the Optimum Moisture Content is not appreciably decreased until the "swell limit" is reached.

Further increase in the moisture content represents a "stage of saturation". During this stage, the air is replaced by water until the "Saturation Limit" is reached. At this point, all the air has been displaced.

Hogentogler has also undertaken to determine the thickness of the water films. The area of the surfaces in a soil mass may be computed by approximate mathematical methods, and an attempt has been made to plot a picture of the water films on a typical clay particle. (see sketch)

For a soil sample containing 44% sand, 44% clay and 12% silt, the calculated surface area is approximately 235,000 square feet per cubic foot. At the hydration limit, assumed at 30.6%, if the air and water were distributed uniformly over the entire surface of the particles, the average thickness would be about 11 x 10^{-6} inches of water film, and 12 x 10^{-6} inches of air film per particle. A thickness of about 5 x 10^{-6} inches would represent the hygroscopic moisture in an air dried sample.

Similarly, if the lubrication limit is taken at 35.1%, the swell limit at 46% and the saturation limit at 64%, the respective moisture films would have thicknesses of 14 x 10^{-6} inches, 22 x 10^{-6} inches and 46 x 10^{-6} inches.

Films differing several millionths of an inch in thickness would seem of little consequence in the case of sand. On a clay particle as small as 1 x 10^{-4} inches (0.0025 mm) in diameter however, such small differences become controlling factors in the behavior of the soil containing the clay.

In the accompanying sketch, the diameter of the particle is compared with the thicknesses of the surrounding films. Then the concept of the nature of the moisture films may be summed up as follows.

(1) During the stage of hydration, the moisture films, - more glue-like and viscous than free water increase to a maximum thickness of 11 x 10^{-6} inches.

(2) During the stage of lubrication, the water films increase in thickness to 14 x 10^{-6} inches - 3 x 10^{-6} inches in excess of the thickness

of the hydration films - acting more like free water, to facilitate compaction. Correspondingly, the air content is reduced to about 3% by volume.

(3) During the stage of swell, the films increase to 22 x 10^{-6} inches, the air content remaining substantially constant. Moisture in films of this thickness and less, is possibly attracted more strongly by the soil particles than by gravity. That is, the films could coat the particles without necessarily filling the air voids between the outer surfaces of the films.

(4) Moisture in excess of the swell limit behaves like free water, attracted more strongly by gravity than by the soil particles. As a result, the moisture gradually replaces the contained air, until the soil becomes completely saturated at an equivalent film thickness of about 46 x 10^{-6} inches. Hydrostatic uplift may not be fully effective until the saturation limit indicative of saturation is reached.

b. MOHR'S THEORY OF RUPTURE AND THE ASSUMPTIONS ON WHICH IT IS BASED

There are several "Theories of Rupture" and these have been discussed in detail by Rutledge in the "Proceedings of the Purdue Conference on Soil Mechanics" . The theory most readily applicable to the study of soil failures is known as Mohr's Theory of Rupture and is the one in general use. It has been pointed out by Prof. I.F. Morrison that this theory is actually a special case of the more general hypothesis referred to as "Van Mises Flow Conditions" and is an extension of Coulomb's theory of earth failure. These are discussed in detail in a later section.

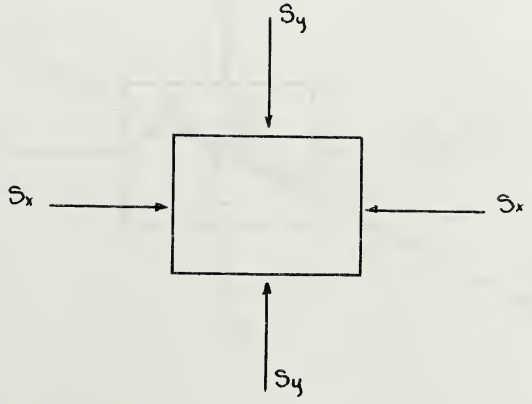
Briefly, Mohr's theory involves a graphical method of representing the relation between shearing stress and normal stress on a plane in a stressed body, referred to as Mohr's Circle of Stress. The tangent to

the series of such circles resulting from tests performed at increasing normal stresses is termed Mohr's envelope. Then Mohr's theory states:

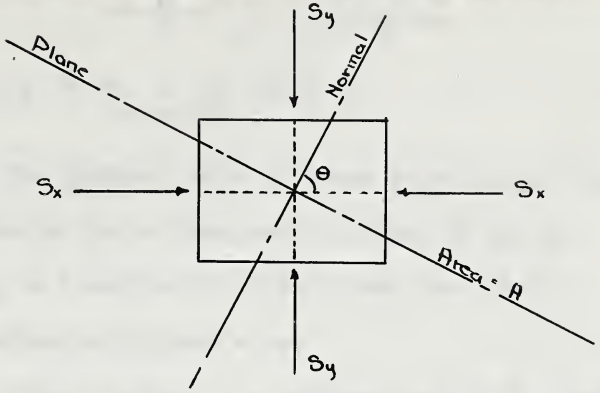
1. Stress conditions on a body such that the Mohr's circles do not come up to this rupture envelope are assumed to be safe and failure will not occur. Conversely stress conditions resulting in a circle tangent to or cutting this envelope are unsafe.
2. This line of rupture is independent of the method by which it is obtained. That is, the same line of rupture will result from determinations of the maximum shearing stresses corresponding to various normal pressures or from determinations of the maximum differences between various combinations of major and minor principal stresses.
3. The line of rupture is independent of the intermediate principal stress.
4. The angle between the line of rupture and a vertical is equal to the angle between planes of rupture in the material at failure.

The development of Mohr's Theory is given here and the assumptions on which it is based are summarized later.

(1) Consider an element acted on by a set of normal forces in two directions as shown.



(2) Consider the state of stress on any plane with a cross-sectional area A whose normal makes an angle θ with the direction of S_x.



The projection of area A in the x direction = A cos θ

The projection of area A in the y direction = A sin θ

a. Then the sum of all forces in the direction of the normal

$$S_n A = (S_x A \cos \theta) \cos \theta + (S_y A \sin \theta) \sin \theta$$

or $$S_n = S_x \cos^2 \theta + S_y \sin^2 \theta \qquad (I)$$

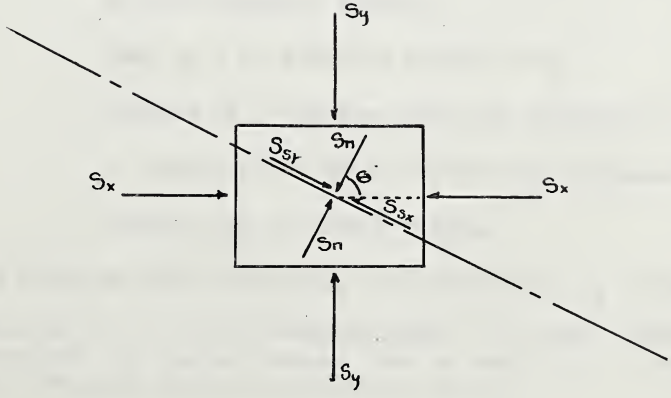
b. The sum of all forces acting along the surface of the plane

$$S_s A = (S_y A \sin \theta) \cos \theta - (S_x A \cos \theta) \sin \theta$$

or $$S_s = \sin \theta \cos \theta (S_y - S_x) \qquad (II)$$

(S_y has a resultant acting down to the right = pos.

S_x has a resultant acting up to the left = neg.)



(3) These equations may be rewritten.

$$(1) \quad S_n = \frac{S_y + S_x}{2} + \frac{S_y - S_x}{2} \cos 2\theta$$

$$(2) \quad S_s = \frac{S_y - S_x}{2} \sin 2\theta$$

(4) Consider the limiting value of these equations and their interpretation for a given set of values of S_x, S_y.

a. S_n is a maximum or minimum when cos 2 θ is a maximum or minimum - or:

Normal stress is a maximum for $\theta = 0^\circ, 180^\circ$

Normal stress is a minimum for $\theta = 90^\circ$

b. S_s is a maximum or minimum when sin 2 θ is a maximum or minimum OR:

Shearing stress is a maximum for $\theta = 45^\circ$

Shearing stress is a minimum for $\theta = 0^\circ, 180^\circ$

c. Thus - Normal stress is a maximum when shearing stress is a minimum.

- Normal stress is a maximum on the Principal planes and shearing stress becomes zero.
- Shearing stress becomes a maximum on a plane at 45° to the Principal planes.
- When $S_x = S_y$ shearing stress = 0.
- Failure of a specimen might be expected to occur by shear, at an angle of 45° when stressed by an unequal set of normal forces.

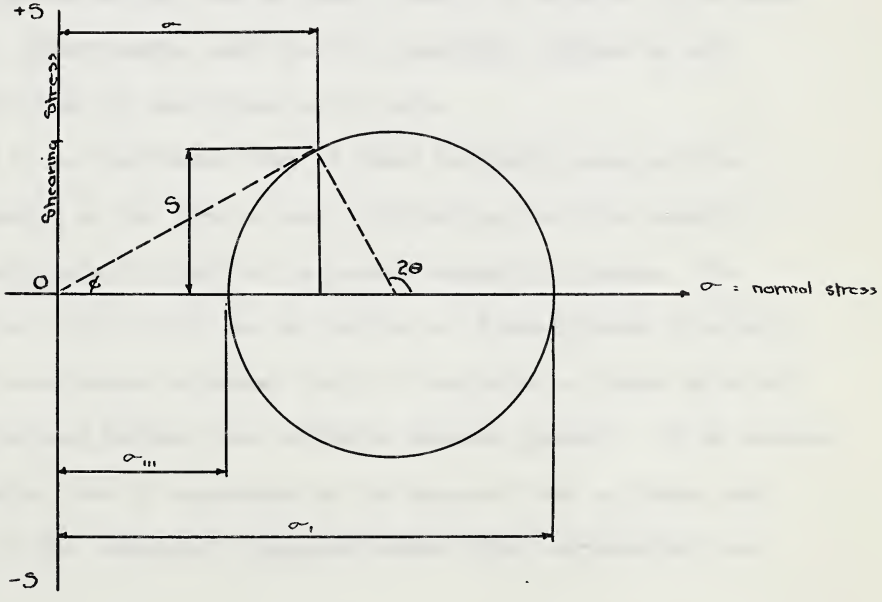
(5) In most texts on soil mechanics, the symbols S_x, S_y as used above are replaced by σ_1, σ_3, respectively. σ_2 would represent the intermediate principal stress and in the case of the ordinary triaxial test, σ_2 is equal to σ_3.

$$S_n = \frac{\sigma_1 + \sigma_{111}}{2} + \frac{\sigma_1 - \sigma_{111}}{2} \cos 2\theta$$

$$S_s = \frac{\sigma_1 - \sigma_{111}}{2} \sin 2\theta$$

For a given set of values of σ_1, σ_{111}, it is seen that the values for S_n, S_s vary with 2θ. If values of S_n are plotted against values of S_s for corresponding values of 2θ from 0° to 360° the resulting curve will be seen to be a circle of radius $\frac{\sigma_1 - \sigma_{111}}{2}$ with its centre at $\frac{\sigma_1 + \sigma_{111}}{2}$.

If such a circle be drawn for a set of normal stresses σ_1, σ_{111}, the shearing stress and normal stress on any plane whose normal makes an angle of 2θ with the direction of σ_{111} can be found.



If $\sigma_{3}'' = 0$, the axial stress σ_{1} may be increased to failure and the Mohr's circle drawn. The value of the maximum shearing stress at failure is seen to be equal to $\frac{\sigma_{1} - \sigma_{3}''}{2}$ which is the radius of the circle. If σ_{3}'' is maintained at an increased value, σ_{1} for failure must also increase. However, the size of the circle as determined by the difference $\sigma_{1} - \sigma_{3}''$ should be the same as the same value of shear should still cause failure, neglecting increased internal friction and increased cohesion between the particles and assuming failure to be entirely due to shear.

Actually it is found that as σ_{3}'' increase, σ_{1} for failure increases more rapidly, resulting in a larger circle, indicating an increased shearing resistance. The tangent to a series of such circles is known as Mohr's envelope, and by Mohr's theory of rupture, all stress conditions on a given sample such that the resulting circles do not come up to this line are considered to be safe.

This line is not horizontal but is found to have a slope of from 0° to 60° depending on the type of soil, indicating that the material has greater resistance to shear at increased compacting forces. The interpretation of this is that as the grains are forced closer together, the frictional resistance increases (with an approximate linear relation) and the cohesive bond between the particles becomes greater. It is assumed that this cohesive bond is dependent on the shape of the particles and on the nature of the previously discussed water films surrounding the particles.

At this point it becomes obvious that a distinction must be made between cohesive and non-cohesive soils.

The mechanical properties of soils range from those of ideal plastic

clay to those of clean, perfectly dry or completely immersed sands. If we dig into a bed of sand the material at the sides, slides toward the bottom. This indicates a complete absence of bond between the particles. The sliding material does not come to rest until the angle of inclinaton of the slopes becomes equal to a certain angle termed the "angle of repose". For cohesionless materials, this angle is independent of the height of the slope.

On the other hand excavations 20 to 30 feet deep may be dug with vertical faces in stiff clay. This indicates that a firm bond exists between the clay particles. However as soon as the depth of the trench exceeds a certain critical value, dependent on the intensity of the bond between the particles, the sides fail. The bond between the particles is called cohesion. No definite angle of repose can be assigned to cohesive soils, as the steepest slope at which such a soil can stand decreases with increased height.

A soil with no cohesion would thus have no resistance to shear at $\sigma_n = 0$ and the Mohr's circle in such a case would be reduced to a point. For an ideal cohesionless soil, the line of rupture would pass through the origin and the angle of inclination of the line would depend entirely on the internal friction of the material. For a cohesive soil, the point at which the rupture line intersects the S_s axis is a measure of the cohesion of the material.

The equation of Mohr's envelope is expressed empirically by Coulomb's equation

$$S = c + \sigma \tan \phi$$

S = Shearing resistance

c = Cohesion (intercept of envelope on S axis)

σ = Normal stress

ϕ = "angle of internal friction" = slope of envelope

The envelope is assumed to be a straight line by Coulombs theory. By this equation, theoretically, if the value of the initial cohesion c and the "angle of internal friction" ϕ were known, the shearing stress at failure could be computed for any value of normal stress. It might be concluded that these factors could be determined by laboratory tests on the soil. However in the case of saturated clay soils of low permeability, the problem becomes more complicated. As an increment of load is added, it is taken initially by the water body, causing an excess hydrostatic pressure. Until enough water can be squeezed out of the sample to reduce this pressure to zero, the full load is not carried by the grain skeleton and the full potential frictional resistance is not mobilized. If failure occurs with an appreciable hydrostatic head present, the shearing resistance at failure will be less than if the full load were being transmitted from grain to grain.

From this it may be seen that the value of ϕ for a clay depends on the rate of loading, the size of the specimen considered, the initial water content and the shape and grain size distribution of the particles. The data obtained from triaxial tests on clay soils must be related to the actual conditions with these considerations in mind.

The fact that when $\sigma_n = 0$, a soil has any shearing resistance at all indicates the presence of a cohesive bond between the individual particles. In the case of cohesionless materials the increase in shearing resistance with increased normal stresses is due entirely to the internal friction between the particles.

For cohesive materials the increased resistance to shear with increased normal stresses is attributed to an increase in the internal friction plus an increase in the cohesive bond between the particles due to a closer proximity of the particles. In this case ϕ cannot be

referred to as the angle of internal friction but is rather the angle of shearing resistance. The difference may be illustrated as follows.

If we take two identical soil samples, we may stress one triaxially from $\sigma = 0$ to $\sigma = \sigma'$, and obtain a value for S_s. If we take the other sample and consolidate it at a pressure of σ'', where σ'' is greater than σ', and then after reducing the pressure to σ', apply the the same test as above, we will obtain a value say of S'_s for the shearing resistance at failure. Now is $S'_s = S_s$ we are justified in referring to ϕ as the angle of internal friction. If S'_s is greater than S_s it becomes apparent that the increased shearing resistance represents the sum of the increased frictional resistance plus some other resistance independent of the normal stress. That is, the resistance $\sigma \tan \phi$ in Coulomb's equation consists of two parts with different physical causes.

1. Increased intergranular friction caused by the normal stress.
2. Increase in the cohesion due to a closer proximity of the grains, permitted by a decrease in the water content resulting from the increased normal stress.

The assumptions on which Mohr's Theory of Rupture is based may be summed up as follows:

1. The equation $S = c + \sigma \tan \phi$ is valid not only for the shear plane but for any other section through a given point of a mass in a state of plastic equilibrium.
2. The soil considered, is always isotropic and homogeneous - the effect of the shape of the particles and possible stratification is neglected.
3. Plastic flow involving a continuous deformation under constant stress has no influence on the values of c, ϕ contained in the equation.

4. Thus both ideal sands and ideal clays are assumed to be capable of flowing indefinitely at unaltered values of c, and ϕ - or that they are ideal plastic materials.
5. The intermediate principal stress has no effect on the shearing resistance.
6. The effects of lateral deformation and change in volume may be disregarded.

c. THE GRAPHICAL CONCEPT OF IDEALLY COHESIVE AND IDEALLY NON-COHESIVE SOILS

On the basis of Coulomb's equation, $S = c + \tan \phi$, Mohr's envelope of rupture is assumed to be a straight line. Thus an ideally cohesive material would have a zero angle of internal friction and its envelope of rupture would become a horizontal line. Its resistance to shear would depend entirely on the cohesion represented by the value of c. Friction between particles would be zero. An envelope of this shape could be obtained by running a series of triaxial tests at increasing lateral pressures on paraffine cylinders. The position of the horizontal line would depend in this case on the temperature of the paraffine - and its resultant viscosity.

Conversely, for an ideally cohesionless material, the value of c would be zero and its resistance to shear would depend entirely on its angle of shearing resistance (or in this case its angle of internal friction), and the value of the normal stress considered. Thus the Mohr's envelope would become a straight line passing through the origin and would have a slope equal to $\tan \phi$. An envelope of this shape is characteristic of clean, dry sand.

If, by some means, cohesive properties could be induced in an ideally cohesionless material as described above and have it retain its frictional

resistance as well, the Mohr's envelope for this material would be displaced to the left of the origin, as the cohesion was increased. The slope would be expected to remain the same. A physical example of a material capable of such induced cohesion might be a mass of uniform particles of iron filings - having no cohesion, but possessing a definite angle of internal friction. An increasing magnetic field would cause increasing cohesion - although the mass would not be ideally isotropic. In this case, the material would possess both cohesive and frictional properties, and the shearing resistance for any value of lateral stress could be expressed by Coulomb's equation - $S = c + \tan \phi$, or if we let P_k represent the value of the tensile strength, determined by the intercept of the tangent to the rupture line with the horizontal axis, we could more properly write the equation

$$S = (P_k + \sigma) \tan \phi$$

and $c = P_k \tan \phi$.

P_k then is a measure of the ability of the material to resist tension and is in accord with the generally accepted conception of cohesion in a material. From this we may conclude that Mohr's circles could be drawn to the left of the origin by using less than atmospheric pressures and performing triaxial tests in the usual manner.

Again considering the material with the induced cohesion, - if the angle of shearing resistance could be decreased say by the addition of a lubricating oil, which, in effect separates the particles, thus reducing the effect at the magnetic field at the cohesion, the slope of the rupture line could be decreased to zero, and the shearing strength of the material would be independent of the normal lateral pressure (assuming the oil to be incompressible). In fact the shearing strength

would now depend entirely on the induced cohesion caused in this case by the magnetic field.

The position of this horizontal line would raise or lower with the intensity of the field.

On the basis of this hypothesis, the shape of the Mohr's envelope can be defined for any isotropic, homogeneous material if two assumptions are made. First it must be assumed that all such materials are either ideally cohesive, ideally non-cohesive or that they possess cohesive properties somewhere between these two extremes. It might be noted that an ideally cohesive material is assumed to have an extremely large value for P_k and a value of ϕ approaching zero. As P_k approaches a large value for a constant value of shearing resistance (depending entirely on the cohesion and independent of the normal stress) the tangent of ϕ approaches zero and ϕ must approach zero.

For soils we must also assume that the triaxial tests are performed so quickly that no consolidation takes place.

The Mohr's envelope for a non-cohesive soil with no moisture film would be expected to be a straight line passing through the origin and having a slope equal to tan ϕ. For the same soil in a perfectly dry condition, but with water films, the envelope would be straight initially and its tangent would again pass through the origin but it would tend to curve at higher normal stresses.

A potentially cohesive soil in a perfectly dry condition without moisture films would act in a manner similar to the non-cohesive soil in the same state. If this soil were perfectly dry but if moisture films were present, the soil might exhibit a small amount of cohesion initially but would also have a large value of ϕ. That is, the horizontal intercept might move slightly to the left of the origin and a large value of ϕ would result in a high initial value of c. As the normal lateral stress

increased, the envelope would curve and ϕ would decrease.

If the moisture content of this soil were increased, P_k would move further to the left, ϕ might have the same initial value as above but as the lateral normal stress increased and as the voids decreased, the size of the lubricated films would increase and ϕ would tend to decrease. Still assuming that no consolidation takes place - that is, that no moisture escapes - a state would soon be reached in which all air spaces in the compacted soil would be filled with free water and further compression would be impossible. Each particle would be surrounded by a thick moisture film and ϕ would become zero - that is the shearing resistance can no longer increase with increased stress as the moisture films are by this time thick enough to have the viscosity of free water. The envelope would then become asymptotic to a horizontal line. The soil would resemble an ideally cohesive material. The cohesive force would then appear to depend on the amount of separation of the particles.

The location of this horizontal asymptote would depend on the moisture content and would tend to coincide with the $T = 0$ axis as the moisture content was increased.

This reasoning could be applied to all cases of soils tested in this manner, to predict the shape of the envelopes. Thus it may be seen that the value of c, ϕ for a soil at a given moisture content will depend on the particular value of the normal stress S considered. The two values at this point are determined by drawing a tangent to the envelope and observing its slope and point of intersection with the shearing stress axis. From these values, the true cohesion P_k may be determined.

In actuality, P_k is a measure of viscosity of the water films surrounding the particles. As the films increase in size and consequently decrease in viscosity, according to Hogentogler's and Terzaghi's theories,

the shearing resistance should decrease also until the cohesion is equal to the intermolecular attraction of the water molecules, when ϕ becomes equal to zero, and the shearing resistance is equal to zero as in the case of free water.

True cohesion in the strictest sense of the word is the intermolecular attraction between the particles and may be disregarded except for perfectly flat, scale - like particles. The probable area of contact of any two particles is statistically small enough to be neglected.

The predicted path of the Mohr's rupture envelope as discussed above would appear to be valid only for that range of stresses less than those which would cause a breakdown of the structure of the particles in the case of undisturbed sedimentary clays, or large enough to cause fracture of the particles themselves. The effects of such internal fractures on the envelope would be a matter of further conjecture and would have to be investigated in more detail.

The transformation of the stress deformation properties from those of an ideally cohesionless material to those of an ideally plastic material has been illustrated mathematically by Frohlich as follows:

"In mechanics, plasticity is not considered a property of the material but rather as a special stress condition.

"Let us consider a body which obeys Hookes law for small loadings. We may stress this body by means of a set of forces in equilibrium and observe the resulting deformation.

"If this set of stresses is increased, the deformation increases in a like proportion. It is obvious that this cannot be carried on indefinitely. At a certain magnitude of the applied force the rate of deformation gradually increases. Thus the material is said to flow and one speaks of a flow limit and a flow condition.

"If the applied stresses are further increased, fracture takes place. Between the flow and fracture limits, the body is in a plastic state.

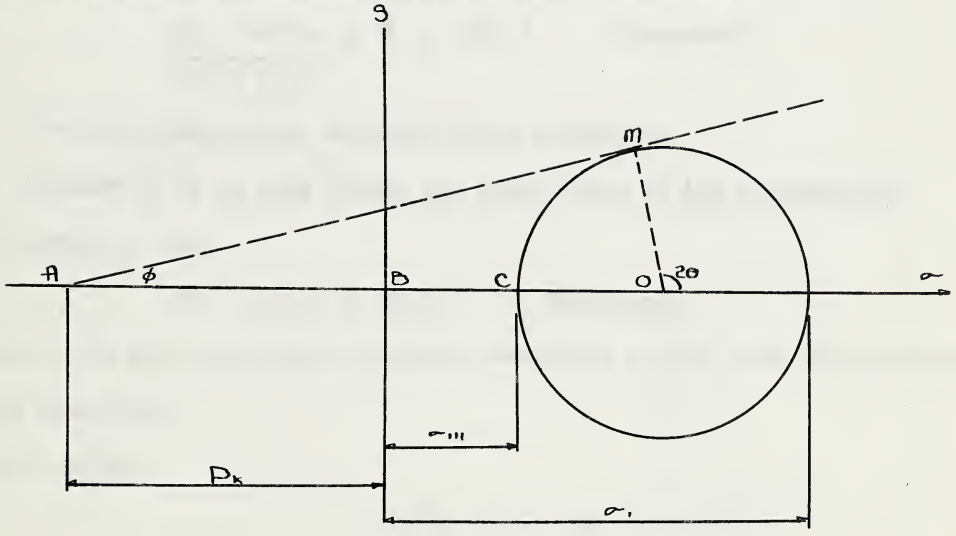
"The "flow condition" is found in the mathematical theory of plasticity expressed by the relation between the principal stresses at a point within the body and the constants for the material.

Von Mises has stated this flow condition thus

$$(\sigma_{,,,} - \sigma_{,,})^2 \neq (\sigma_{,} - \sigma_{,,,})^2 \neq (\sigma_{,,} - \sigma_{,})^2 = F(\sigma_{,} \neq \sigma_{,,} \neq \sigma_{,,,})$$

where $\sigma_{,}$ is greater than $\sigma_{,,}$, greater than $\sigma_{,,,}$ (magnitude of principal stresses).

If we consider the familiar Mohr's circle diagram.



Stress conditions such that the circle is tangent to or cutting the envelope as shown is unsafe and represents a "flow condition" - that is under such a stress condition, the material is plastic and a small increase in stress results in a large deformation. Thus Mohr's "flow condition" might be expressed.

$$(\sigma_{,} - \sigma_{,,}) - 2K \left(P_k \neq \tfrac{1}{2} (\sigma_{,} \neq \sigma_{,,,})\right)$$

σ_1 = major principle stress

σ_3 = minor principle stress

K = sin ϕ (ϕ = angle of internal friction)

P_k = tensile resistance as shown

The geometrical aspect of this may be observed in the above sketch. It might be noted that Mohr's theory assumes the rupture envelope to be independent of the intermediate stress. It has also been shown that this "flow condition" is a special case of "Von Mise's Condition".

" Now for an ideally cohesionless material, P_k becomes zero and Mohr's flow condition becomes

$$\frac{\sigma_1 - \sigma_3}{\sigma_1 + \sigma_3} = K = \sin \phi \qquad \text{(constant)}$$

" This has been termed Rankine's flow condition.

In addition if P_k is very large, the second term in the brackets may be ignored, - then

$$\sigma_1 - \sigma_3 = 2K P_k \qquad \text{(constant)}$$

This is the case for ideally cohesive materials and is known as Coulomb's flow condition. "

Now if we let

$$\sigma_1' = \sigma_1 + P_k$$
$$\sigma_3' = \sigma_3 + P_k$$

Then

$$\frac{\sigma_1' - \sigma_3'}{\sigma_1' + \sigma_3'} = K = \sin \phi$$

Thus a cohesive soil may be brought under the condition for a non cohesive soil if time is allowed for the hydrostatic forces to become adjusted.

The conclusion is that the Mohr's envelope for a cohesive soil sample is a curved line asymptotic to some value of shearing resistance depending on the moisture content.

ϕ, and c are not physical constants for a given soil except for a slow rate of loading, in which consolidation is allowed to take place under each increment of load. For quick loading these values are affected by the rate of loading as well as by the moisture content and the particular normal stress considered. ϕ is the angle whose tangent is equal to the slope of the envelope at any point, and represents the rate at which the shearing stress increases with increasing normal pressure. When the shearing stress ceases to increase with increasing normal stress, ϕ is said to be o. and the shearing strength remains constant at a value depending on the cohesion - and is independent of the normal stress.

It has been observed that the grain size of a soil affects the angle of shearing resistance. In this connection, it has been pointed out by Terzaghi [96] on the basis of the behaviour of the adsorbed water films that for a similar constant rate of loading, the degree of solidification in a highly colloidal clay is likely to be far less advanced at the instant of failure than in a leaner clay. If this is the case, the increase in the shearing resistance due to a given increase in the normal stress on the surface of sliding should decrease with decreasing grain size. As the state of failure in a shear test on clay is approached, the presence of the water films between the clay particles should cause the clay to flow at a constant stress like a viscous liquid.

SUMMARY OF RESULTS OF TRIAXIAL TESTS

The values of c, ϕ, P_k as obtained from the plot of Mohr's envelope have been tabulated here according to the corresponding moisture content and dry density for each test.

I. Regina Samples.

QR 3U SG 06

Moist. Cont.	21.0	23.4	26.3	28.1	30.7	35.7	41.0	51.4
Dry Density	92.9	94.7	95.0	94.0	87.2	81.2	77.6	65.7
ϕ	34.1	27.2	37.0	7.6	25.8	13.5	3.1	0.0
Cohesion c	1.81	1. 40	0.85	1.10	0.68	0.50	0.35	0.13
Cohesion P_k	2.68	2.73	1.13	8.24	1.41	2.08	6.43	Inf.

QR 5U SG 06

Moist. Cont.	21.5	24.5	26.5	29.7	32.8	39.8	43.6
Dry Density	92.0	92.8	92.5	89.5	85.0	77.0	72.4
ϕ	49.7	30.8	35.7	32.7	11.4	2.3	0.0
Cohesion c	0.50	1.60	0.81	0.85	0.80	0.83	0.47
Cohesion P_k	0.42	2.68	1.13	1.32	3.97	2.07	Inf.

QR 6U SG 06

Moist. Cont.	17.9	21.8	22.4	25.0	29.5	33.8	34.8	37.9
Dry Density	91.0	91.8	89.7	91.3	90.0	85.6	75.5	72.3
ϕ	49.3	42.4	38.3	39.1	29.5	0.0	4.5	4.9
Cohesion c	0.71	1.60	1.63	1.53	0.40	1.45	0.83	0.52
Cohesion P_k	0.61	1.76	2.07	1.89	0.71	--	10.65	6.64

QR 7U SG 06

Moist. Cont.	23.5	26.8	28.4	31.5	34.0	37.1	41.5
Dry Density	90.0	90.9	91.1	89.0	83.3	78.4	73.2
ϕ	40.8	30.5	26.2	13.2	13.7	3.7	0
Cohesion c	0.48	1.20	1.10	1.02	0.82	0.70	0.45
Cohesion P_k	0.55	2.04	2.24	4.36	3.37	10.81	Inf.

QR 8U SG 06

Moist. Cont.	15.7	18.1	21.5	24.1	28.1	33.0	37.9	43.0	45.4	49.4
Dry Density	92.7	93.0	94.4	91.0	91.9	83.2	79.0	74.1	73.9	68.6
ϕ	53.7	49.0	46.7	40.0	8.3	6.8	2.2	5.5	4.4	0.6
Cohesion c	0.60	0.78	1.12	1.21	2.57	1.10	0.63	0.32	0.46	0.22
Cohesion P_k	0.44	0.68	1.06	1.44	17.60	8.36	16.4	3.31	6.00	21.70

II. Lethbridge Samples.

QL 100U SG 612

Moist. Cont.	12.6	14.9	16.3	18.3	20.1	22.7	27.6
Dry Density	109.8	112.6	111.0	106.6	104.4	99.4	91.5
ϕ	34.9	37.9	38.8	12.1	12.1	3.1	0
Cohesion c	2.05	0.90	0.91	1.10	0.72	0.48	0.15
Cohesion P_k	2.93	1.15	1.13	5.13	3.36	8.85	Inf.

QL 101U SG 1218

Moist. Cont.	12.3	16.3	18.6	21.0	24.2	28.5	31.9	35.5
Dry Density	107.0	102.5	100.2	103.4	98.2	92.5	87.0	81.2
ϕ	27.9	12.9	34.2	12.0	5.4	0	0	0
Cohesion c	2.50	3.19	1.40	1.40	0.88	0.63	0.34	0.23
Cohesion P_k	4.73	3.90	2.06	6.30	9.32	--	--	--

QL 102U SG 1218

Moist. Cont.	7.5	9.6	11.0	14.0	16.4	17.3	20.8	21.1	27.0
Dry Density	114.6	116.0	120.0	116.5	114.0	111.0	101.8	102.6	91.8
ϕ	48.2	31.1	20.1	15.7	9.6	6.4	4.6	4.6	0.0
Cohesion c	0.74	2.22	3.21	0.95	0.90	0.47	0.25	0.25	0.07
Cohesion P_k	0.66	3.67	8.78	3.38	5.33	3.99	3.18	3.18	Inf.

QL 103U SG 1218

Moist. Cont.	7.8	9.6	10.8	13.7	15.9	17.2	20.4	22.8	25.2
Dry Density	114.0	115.4	116.2	107.0	110.8	111.8	104.0	98.8	95.0
ϕ	46.6	26.6	33.9	17.9	21.8	25.0	0	0	0
Cohesion c	1.14	2.40	2.00	1.54	0.72	0.40	0.24	0.24	0.13
Cohesion P_k	1.08	4.80	2.98	4.76	1.80	0.86	--	--	--

QL 104U SG 1218

Moist. Cont.	9.4	10.8	12.4	14.0	16.1	20.7	22.5	25.0
Dry Density	114.5	115.8	115.8	115.0	112.0	104.0	100.3	94 .5
ϕ	42.7	34.8	42.9	27.5	9.6	0	0	0
Cohesion c	0.97	1.71	1.10	1.00	1.00	0.35	0.24	0.13
Cohesion P_k	1.06	2.46	1.18	1.92	5.92	--	--	--

DISCUSION OF THE RESULTS OF THE INVESTIGATION

a. EFFECT OF THE RATE OF LOADING ON THE STRESS DEFORMATION PROPERTIES OF THE SOIL - During some of the tests performed earlier in the investigation, the loading was not maintained at a constant rate. It was observed that an increased rate of loading resulted in a flattening of the stress-deformation curves and decreased the shearing strength at failure. This can be accounted for on the basis of the nature of the water films discussed previously.

With increasing distance from the surface of the solid, both the density and viscosity of the water decrease. Beyond a certain distance, the properties of the water are normal. Terzaghi[9b] claims this distance depends both on the chemical properties of the solid and on the substances other than water present in the zone of adsorbtion. Thus, for instance if the water in the voids of a bentonite specimen contain sodium salts in solution, the adsorbed layers are much thicker than those in one saturated with pure water. As a matter of fact this is the condition existing in samples of Lethbridge clay.

As two particles in an earth mass are forced together by an applied pressure, the load is transmitted initially by the water layers and they are still separated from each other by a liquid though very viscous layer of adsorbed water. The further approach between the particles takes place at a rapidly decreasing rate until finally the solid portions of the adsorbed films come into actual contact. The gradual development of a solid bond between the clay particles is referred to as the "process of solidification."

Before the clay is completely solidified some of the particles are already connected with each other by a solid bond due to direct contact between the solid parts of the adsorbed layers. Others are held together

by the highly viscous liquid portion of the layers. Both type of bond participate in the transmission of stress from grain to grain. Hence it is necessary to subdivide the effective stress in a clay into two parts.

One part, the solid bond stress is entirely carried by the bond between the solid portion of the adsorbed layers. The second part, the film bond stress is carried by the viscous resistance of the adsorbed films. As long as part of the effective stress consists of film bond stress, the stress produces a slow, viscous intergranular movement. This may be observed during the loading process of the triaxial test and is shown by the continuous variation in the strain guage readings. This state of the clay is termed the "lubricated state" by Terzaghi. As the solid state is approached, the degree of lubrication decreases.

If however, an additional increment is added before the previous load is consolidated the moisture has not been allowed to escape and the soil is still in a "lubricated state". Consequently the intergranular movement continues to take place at a relatively rapid rate. Thus the rate of deformation is directly affected by the rate of loading - or if the increment is the same for both, an increased rate of loading results in an increase in the rate of deformation with increased stress. This is supported by the observed behavior of the stress-deformation curves.

b. STRESS-DEFORMATION CURVES - These curves appear to be divided into three phases. They initially proceed at a relatively steep slope (comparable to the line from which the Modulus of Deformation may be obtained). A definite break occurs and the curve follows a relatively straight path to an upper limit at which a further sharp break occurs. The specimen has usually failed at this point and cracks and bulges are evident. The specimen normally continues to withstand further loading

but at an increased rate of strain and the curve follows a relatively flat path.

In some cases, a knee is observed in the intermediate phase above. As a general rate, the intermediate section has a definite slope that can be measured fairly accurately. This slope appears to vary directly as the intensity of the minor principal stress, and reaches steeper slopes with decreased moisture content.

Tentatively the division between these three planes might be termed the elastic limit, the flow limit, and the end point may be referred to as the fracture limit. It has been noted by Prof. I.F. Morrison that the distance between these latter two points is an indication of the particular flow condition of the soil. The two points lie closer together for brittle samples and diverge with increased plasticity.

c. MODULUS OF DEFORMATION - Soils do not follow Hooke's law directly and the modulus of elasticity for a soil must be expressed as a function of the modulus of the particles themselves, the voids ratio, the water content and the confining pressures. It has been observed that the first reach of a stress strain curve for sand is approximately a straight line. J.D. Watson in the Proceedings of the Purdue Conference on Soil Mechanics has termed the slope of this line the "Modulus of Deformation" of the sand for the particular test.

Watson states that as this line is not invariably straight, the slope of a chord to the curved line will be termed the "Modulus of Deformation". "This chord is arbitrarily drawn from the point of divergence of the major and minor principal stresses to that point on the stress strain curve where the major principal stress reaches a value which exceeds the minor principal stress by one third the maximum difference

between the major and minor principal stresses."

The practice of obtaining a value for this "Modulus of Deformation" of clay soils by measuring the slope of a tangent to the stress strain curve is not justified. Actually such a process might be made more accurate if the rate of loading were very small - that is if accurate strain readings could be taken for very small increments of load. At this point the question of piston friction arises.

A great deal of work has been done on the problem of eliminating this piston friction. A possible answer to this would be the use of a strain gauge within the pressure chamber, measuring directly the force actually transmitted by the piston to the sample. This has been tried at the Massachusetts Institute of Technology by using a proving ring, but this results in a more complicated setting up process. However a Rochelle crystal inserted between the piston and cap would be directly affected by the load. It could be waterproofed by "koroseal" and the wires led out through grommets to a simple radio amplifier. The stress would register as a voltage and could be calibrated accordingly. The strain resulting from the compression of the crystal would be negligible. One disadvantage, possibly, would be the chance of a sudden jar fracturing the crystal. A quartz crystal could be used in a similar manner but would require a more powerful amplifier. The method of loading could then be simplified.

It is suggested also that if such a device were obtained the rate of loading could be made constant by the use of a method similar to that used in the cement briquette testing apparatus. This would further eliminate friction in the piston and reduce the possibility of jerky readings of the strain gauge.

From a study of the stress-deformation curves obtained no conclusive

conclusion can be obtained concerning the effect of the moisture content or normal stresses on the modulus of deformation. If use is to be made of the modulus of deformation of a soil, represented by the initial slope of the stress deformation curve, for airport runway design for instance, the method of obtaining such a curve must be modified. The rate of loading must be specified and for a representative curve to be obtained, the effect of piston friction must be overcome - possibly in the manner discussed above.

The term "elastic limit" has been mentioned. This point represents the stress at which the first major break in the stress deformation curve occurs. It is conceivable that the strain registered up to this point is accounted for by elastic deformation - without actual destruction of the "solid bond" or "film bond" developed during the solidification process. The secondary reach of the curve would thus represent an intergranular sliding or shearing action and a deformation caused by the squeezing out of moisture from the films to the adjoining voids. The final phase would represent plastic flow taking place after the ultimate shearing strength of the soil had been exceeded. In the case of drier samples this last phase is eliminated by the tendency of the soil to fracture suddenly.

d. MOHR'S ENVELOPE OF RUPTURE - From an examination of the Mohr's circles and the envelope of rupture it is evident that this envelope is not a straight line but tends to curve as the normal stress is increased. The initial slope of the envelope increases ~~(did)~~ inversely as the water content and for some samples reached values up to 54°. The tendency of the envelope to curve is more pronounced as the moisture content is increased and appears to become asymptotic to a horizontal line representing some constant value of shearing resistance. The location of this

horizontal line depends on the moisture content and tends to coincide with the line of zero shearing strength as this moisture content is increased further.

From the theory of the determination of the liquid limit we might expect this line to represent a shearing value of 0.027 Kg/Cm^2 at the liquid limit for the particular soil.

A standard rubber membrane was used for all the tests. These membranes have a thickness of 0.4 mm - and as the intrinsic value of shearing resistance of the soil decreases, the restraining effect of the membrane - about 0.05 to 0.10 Kg/Cm^2 - becomes more pronounced - thus decreasing the accuracy of the results.

If an angle of ϕ and a value of c is to be determined for a soil by a quick triaxial test, two cylinders should be tested at 0 #/Sq.In. and two at 15 #/sq.in. as well as one at 30 #/sq.in. lateral pressure, as the values from the first two tests are usually the critical ones.

An examination of the compressive strengths of the samples at 0 #/sq.in. lateral pressure for various moisture contents shows that for very dry conditions, the compressive strength is low. With increased moisture content, the compressive strength increases to a certain point and subsequently decreases. The addition of water apparently increases the cohesion until this effect is offset by the increasing distance of separation of the particles caused by the increased thickness of the water films.

e. THE NATURE OF THE COHESIVE FORCES IN CLAY SOILS - All natural phenomena appear to be of an electrical nature to varying extents. In clay soils, as the moisture is increased, the effect of increased normal stress on the shearing strength of the soil is then decreased, (for non consolidated increments). Under these conditions, the shearing

strength of the soil is independent of the normal stress and depends entirely on the cohesion between particles. This cohesive force appears to vary directly with the moisture content and consequently with the distance of separation of the particles, - possibly as the square of the distance. An electro-chemical explanation for this action would thus be feasible.

Then the cohesive force varies with the thickness of the films. The thickness of the films in turn depends on the force of attraction between the soil particle and the water forming the film. This force of attraction depends on the chemical composition of the particle and the nature of the exchangeable bases in solution in the water layers.

It has been stated by Grim in the Proceedings of the Purdue Conference on Soil Mechanics that by the nature of their chemical composition, certain minerals characteristic of clay soils, possess the ability to form thick water films in varying degrees. "The increase in volume (swelling) results from layers of water which develop between the basal cleavage planes of the lattice structure of the clay minerals". The relative ability of different minerals to adsorb water is illustrated by the following table reprinted from Grim's article.

MATERIAL	Adsorbed Water % dry weight of material	Time required to adsorb max. quantity of water
Na-Montmorillonite	700	10 hours
Ca-Montmorillonite	300	40 minutes
Kaolin	90	20 Minutes
Mica	125	25 seconds
Quartz Sand	27 - 32	10 - 23 seconds

The prairie clays are feldspathic origin and contain a large amount of bentonite, which may be classified as of the montmorillonite group.

Various writers point out that the presence of a small amount of montmorillonite in a clay may exert an influence on the physical properties of the soil out of all proportion to its actual abundance. From an analytical standpoint, it is therefore necessary to determine all of the minerals in a clay or soil even though the procedure is considerly lengthened.

Thus a soil containing minerals capable of forming thick films would be likely to be more impermeable, less subject to frost heave, possess greater tendency to swell and consequently to have a higher swelling pressure than soils which do not contain such materials. In addition the presence of thick water films would tend to reduce the compacted dry density of the soil. It is also feasible that the characteristics of a soil could be affected by the addition of such minerals.

Grim points out that the tendency to form thick films also varies with the exchangeable base of the mineral. Montmorillonite clays containing sodium as an exchangeable base can take up two to three times as much water as a similar clay containing calcium.

This property of a clay then is dependent on the ionizing tendencies of the minerals in association with each other and on the electrolytic nature of the water present. Further investigation of the nature of the cohesive forces between clay particles should thus be carried on from an electro-chemical basis.

f. THE MOISTURE CONTENT COMPRESSIVE STRENGTH RELATION - It was found that when the moisture content in % dry weight was plotted against the log of the compressive strength ($\sigma_1 - \sigma_3$) the points showed a linear relation. The effect of variations in lateral pressure is shown by a lateral displacement of the points representing each cylinder for similar moisture contents. It can be seen that as the soil approaches a saturated condition the three points tend to become superimposed for similar values of the voids ratio.

We might also assume that for a saturated condition, if the tests were rigorously standardized, the resulting points would conform more closely to a straight line.

If we make this assumption, the conclusion is that the relation between compressive strength and moisture content is expressed by the equation

$$(\sigma_1 - \sigma_3) = K e^{-rw}$$

- where K, -r are constants for the soil.

w is water content in % dry weight of soil.

If this relation or "flow condition" were valid, although necessarily approximate, its uses would be many. The determination of the values of K, -r for a particular soil would be rather too involved for practical use by the method used here however. If some relation between -r and some other constant for the soil could be found, the matter would be simplified.

The values of K, -r for the samples tested have been tabulated on the following page. The slope of the plot is determined by the value of -r and the location by the value of K.

The significance of this flow condition is not very far reaching in its present form however. The value of w used represents the moisture

content as a % dry weight. Actually it would seem more logical if the moisture content were expressed as a % of total volume, or better still, reduced to a value of thickness of the water film surrounding the particles. Thus -r is a function of the specific gravity, the size, shape and chemical composition of the particles and possibly of the electrolytic properties of the water. K in turn depends on -r and may not be constant for all values of -r, w. In addition it must be kept in mind that this equation applies only to saturated soils under rapidly applied loads - and probably at moisture contents somewhat less than the liquid limit.

Airport	Sample	K	-r
Regina	QR 3U SG 06	155.0	0.1308
	QR 5U SG 06	167.0	0.1241
	QR 6U SG 06	123.1	0.1145
	QR 7U SG 06	180.0	0.1267
	QR 8U SG 06	96.0	0.1088
Lethbridge	QL 100 U SG 612	240.5	0.2500
	QL 101 U SG 1218	80.6	0.1495
	QL 102 U SG 1218	180.9	0.2740
	QL 103 U SG 1218	60.6	0.2328
	QL 104 U SG 1218	90.2	0.2328

From this discussion it is reasonable to assume that a relation might exist between -r and the value of the liquid limit or possibly the flow index for the soil.

In the case of the Lethbridge soils, it may be noted that the point representing the compressive strength at the liquid limit falls on the

line passing through the other points with one exception. This does not seem to hold for the Regina soils.

However let us for a moment assume that the liquid limits for the Regina soils are in error and that the point does conform to the line. This is partially justified by the fast that in obtaining the liquid limit for those soils, the samples were broken down to pass a 200 mesh sieve and the limits were affected accordingly. For the compression tests, a number 4 sieve was used.

If the point representing the compressive strength at the liquid limit is on the line, one end of the line is located. If some means could be found of determining the value of -r, the slope would be known,

$$-r = \frac{2.303}{s}$$

where s is the difference in moisture content for the intercepts of the water content vs. compressive strength curve over one cycle of the graph. It may also be shown that -

$$\log_e K = -mr$$

and $$\log_e K = -Lr - 2.919$$

or $$K = e^{-Lr - 2.919}$$

where m is the moisture content for a value of compressive strength of 1.0 Kg/Cm^2, and L is the liquid limit for the soil.

OR $$(\bar{o}, - \bar{o}_{,,,}) = e^{-r\,(L - w)} - 2.919$$

SUMMARY OF CONCLUSIONS

1. The most obvious result of the investigation is the fact that a small variation in moisture content has a large effect on the shearing strength of the soil.
2. The angle of internal shearing resistance decreases with increased moisture content.
3. The true cohesion P_k of the soil increases with increased moisture content. The combination of the above two factors influence the value of c - the so called "cohesion" - accordingly.
4. The envelope of rupture is not a straight line. Its location and path are determined by the size, shape and chemical composition of the soil particles, the moisture content and rate of loading used.
5. The hypothesis proposed in the section "The Graphical Concept of Ideally Cohesive and Ideally Non Cohesive Materials" discussed previously appears to have some justification. This theorem is based on theorems concerning the nature of the water films surrounding soil particles. Then the following possibilities are apparent.
   a. The stress deformation properties of clay soils depend directly on the nature of the water films - more precisely on the thickness of the films.
   b. The thickness of the water films depends on the type and quantity of the minerals present in the clay and on their chemical constituents as well as on the electrolytic properties of the water forming the films.
   c. Further investigation of the nature of the cohesive force between clay particles should be carried on from an electro chemical standpoint.

6. In order to obtain a value of ϕ, c for a soil by means of a triaxial test, two modifications are suggested to the standard procedure. First, five cylinders should be tested - two each at 0, 15 pounds per square inch and one at 30 pounds per square inch. For clay soils the first two tests determine the value of c, ϕ.
Second, a record of the type of fracture should be made. For sudden crumbling or shearing, no correction should be made to the area due to strain. This will eliminate the concave bend in the stress-deformation curve.

7. The relation between moisture content and shearing strength of a soil may be expressed by the equation

$$(\sigma_1 - \sigma_3) = e^{-r(L - w) - 2.919}$$

where $-r$ is a constant for the soil

L is the liquid limit in % dry weight

w is the water content in % dry weight

This is applicable to saturated compacted soils under rapidly applied loads at moisture contents less than the liquid limit for the soil.

APPENDIX

1. The relation between moisture content and compressive strength for saturated compacted clay soils at failure or "in a state of plastic equilibrium" has been expressed by the equation,

$$(\bar{\sigma}_1 - \bar{\sigma}_3) = e^{-r(L-w)} - 2.9188$$

The derivation of this relation is worked out below.

2. Notation

$\bar{\sigma}_1$	- major principal stress Kg/Cm^2
$\bar{\sigma}_3$	- minor principal stress Kg/Cm^2
$\bar{\sigma}_1 - \bar{\sigma}_3$	- maximum compressive stress Kg/Cm^2
K, r	- constants for the particular soil
w	- moisture content
w_1	- moisture content at which $(\bar{\sigma}_1 - \bar{\sigma}_3) = 1.0$ Kg/Cm^2
w_2	- moisture content at which $(\bar{\sigma}_1 - \bar{\sigma}_3) = 10.0$ Kg/Cm^2
L	- moisture content at the liquid limit.
	Note - all moisture contents are expressed as a per cent of dry weight of soil.
e	- base of naperian logarithms.

3. It has been established that for the conditions specified above, when the moisture content is plotted against the log of the compressive strength, a straight line graph results. Then the relation between compressive strength and moisture content is expressed by the equation,

$$(\bar{\sigma}_1 - \bar{\sigma}_3) = K e^{-rw}$$

The value of the constants K, r are determined from the equations

$$\log (\bar{\sigma}_1 - \bar{\sigma}_3) = \log K - wr \log e$$

then $\log 1.0 = \log K + w_1 r \log e$

and $\log 10 = \log K + w_2 r \log e$

$$w_2 r \log_{10} e - w_1 r \log_{10} e = 1$$

$$r_1 = \frac{1}{(w_2 - w_1)\log_{10} e} = \frac{2.3026}{w_2 - w_1}$$

and $$\log_{10} K = -w r \log_{10} e = -\frac{w_1}{w_2 - w_1}$$

$$K = e^{-w_1 r}$$

4. From these relations it may be seen that the slope of the plot depends on the value of r and the location on the value of K.

5. K may be eliminated at this point and the equation becomes -

$$(\bar{\sigma}_1 - \bar{\sigma}_{1,1}) = e^{-r(w_1 - w)}$$

The values of K, r can be determined from experimental results. If the equation is to be used to predict the strength of a soil at a given moisture content, it must be simplified. The equation still contains two unknowns. The quantity w_1 may be eliminated however. It is known that the compressive strength of a soil is equal to 0.054 Kg/Cm^2 at the liquid limit, from the principle on which the test is based. The moisture content at the liquid limit is easily determined. Then, if this point is assumed to conform to the straight line plot

$$\log 0.054 = \log K + L r \log e$$

$$\log_e K = \log_e 0.054 - L r$$

$$= -2.9188 - L r$$

$$K = e^{-Lr - 2.9188}$$

Then

$$(\bar{\sigma}_1 - \bar{\sigma}_{1,1}) = e^{Lr - 2.9188} \cdot e^{-rw}$$

$$(\bar{\sigma}_1 - \bar{\sigma}_{1,1}) = e^{-r(L - w)} - 2.9188$$

RECOMMENDATIONS FOR FURTHER INVESTIGATION

1. The relation between moisture content and shearing strength has been established for prairie clays at least. If this is to be of practical value some more simple means of determining the value of the constant r for soil samples must be found. An investigation of the nature of this constant is indicated.

2. The effect of the rate of loading on the stress-deformation properties of clay soils has been discussed and modifications to the present triaxial equipment appear advisable. Work could be done on the development of a pressure cell based on the piezo-electric crystal principle for measuring directly the load actually transmitted by the piston to the soil sample.

3. For clay soils, the permeability, susceptibility to frost heave, swelling pressures, and the relative effect of moisture on the shearing strength, depend on the nature of the water films surrounding the particles - and consequently on the ability of the particles to form thick films. An investigation of the surface phenomena of water films on soil particles from an electro-chemical point of view would lead to a better understanding of the problems encountered in the use of prairie clays as a material of construction.

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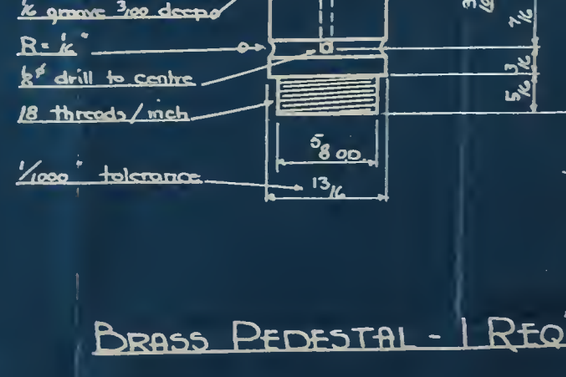
ACKNOWLEDGEMENTS

The author wishes to express his appreciation to the undermentioned for their contributions to the investigation.

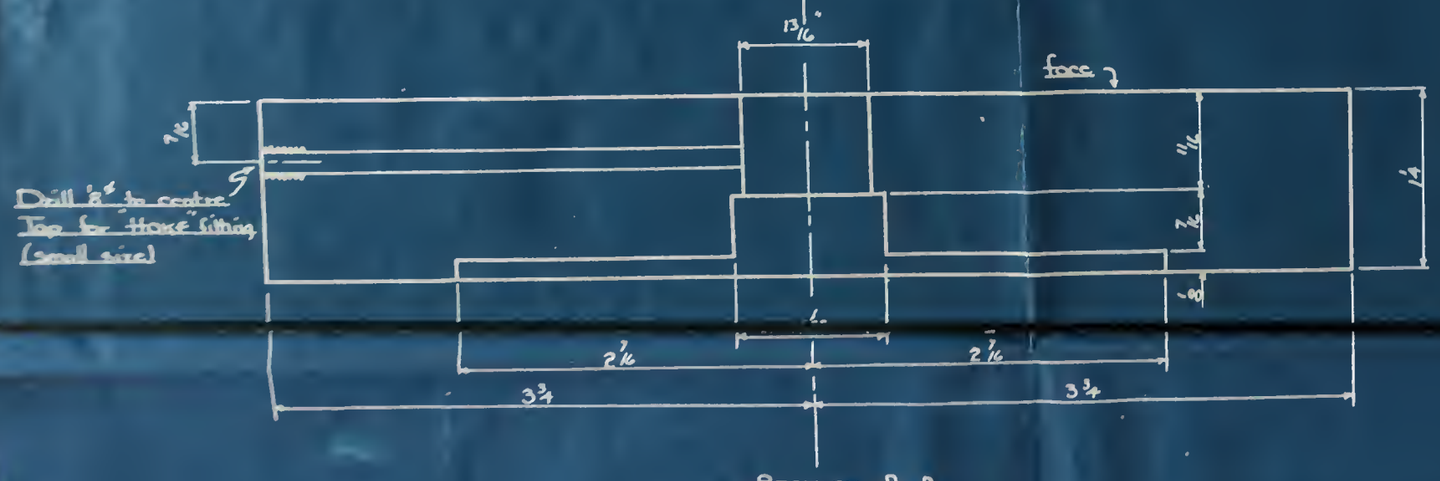
Dean R.M. Hardy - for his advice and criticism.

Professor I.F. Morrison - for his advice and his translation of several reference articles from the German.



PLAN

BRASS PEDESTAL - 1 REQ'D



SECTION A-A

Q'D

Triaxial Compression Apparatus
Baseplate And Pedestal Details

University of Alberta

Scale - Full Size

R.H. Hislop

University of Alberta

Proctor-Triaxial Data

Soil Sample QL 100U SG 612 TEST OM -4%

Modified Proctor Compaction

Optimum Moisture Content	16.0
To be compacted at	10.0
Allowance for evaporation	1.5
Total moisture to be added	13.5
Wt. of oven dried soil	4300
Volume of water added cc.	581

	B2 (1)	S (2)
No. of dish	125	116
Dish soil + water	206.3	214.5
Dish + soil	193.6	200.8
Dish	94.5	91.2
Water	12.7	13.7
Soil	99.1	109.6
Water Content dry wt.	12.8	12.5
Proctor cyl. + wet soil	4032	3633
Proctor cylinder	2150	1742
Wet soil	1882	1891
Dry soil	1670	1683
Equivalent Sp. Gr.	1.768	1.745
Dry Density	110.5	109.0

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	109.8	#/Cu.Ft.
Water content	12.6	%
ø	34.9°	
c	2.05	tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 — 0	2 — 15	3 — 30	4
Applied Load gms	Dial Readings			
0	9710	9580	9680	
20	9650	9565	9675	
50	9620	9540	9665	
100	9550	9470	9645	
200	9410	9310	9570	
300	9260	9130	9465	
400	9120	8950	9350	
500	8950	8760	9240	
600	8790	8600	9120	
700	8640	8440	9000	
800	8495	8380	8880	
900	8350	8140	8760	
1000	8230	8020	8640	
1100	8110	7880	8520	
1200	7990	7760	8390	
1300	7870	7640	8260	
1400	7760	7530	8160	
1500	7640	7420	8060	
1600	7470	7320	7960	
1700	———	7210	7860	
1800		7110	7730	
1900		6990	7580	
2000		6870	7440	
2100		6750	7260	
2200		6540	7080	
2300		———	6810	
2400			6510	
2500			———	
2600				
2700				
2800				
2900				
3000				
Length	3.00"	3.20"	3.45"	
Dish No.	136	M6	17A	
S, W + D	242.5	269.8	242.7	
Soil + Dish	226.1	249.9	225.5	
Wt. Dish	99.2	87.8	86.2	
Water	16.4	19.9	17.2	
Soil	126.9	162.1	139.3	
Water Content	12.9	12.2	12.3	
σ_1	0	1.05	2.11	
σ_{III}	7.73	11.42	13.27	

University of Alberta

Proctor-Triaxial Data

Soil Sample QL 100U SG 612 TEST OM -2%

Modified Proctor Compaction

Optimum Moisture Content	16.0	
To be compacted at	14.0	
Allowance for evaporation	1.5	
Total moisture to be added	15.5	
Wt. of oven dried soil	4300	
Volume of water added cc.	666	
	B2 (1)	S (2)
No. of dish	M 7	111
Dish soil + water	233.1	229.1
Dish + soil	214.9	211.3
Dish	95.2	90.7
Water	18.2	17.8
Soil	119.7	120.6
Water Content dry wt.	15.2	14.7
Proctor cyl. + wet soil	4099	3775
Proctor cylinder	2150	1742
Wet soil	1949	2033
Dry soil	1690	1770
Equivalent Sp. Gr.	1.788	1.832
Dry Density	111.8	114.5

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	112.6	#/Cu.Ft.
Water content	14.9	%
ø	37.9	°
c	0.90	tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4 45
Applied Load gms	Dial Readings			
0	9860	9780	9620	9780
20	9850	9760	9610	9775
50	9840	9730	9600	9770
100	9770	9640	9580	9745
200	9380	9380	9450	9540
300	8980	9100	9210	9220
400	8540	8780	8970	8930
500	8130	8480	8640	8610
600	7740	8140	8350	8270
700	7240	7850	8040	7930
800	6540	7560	7720	7610
900	———	7270	7410	7310
1000		6990	7100	7010
1100		6680	6840	6720
1200		6360	6420	6440
1300		6070	5960	6120
1400		5670	4750	5810
1500		5270	———	5470
1600		4510		5200
1700		———		4860
1800				4470
1900				3980
2000				3400
2100				2470
2200				0010
2300				———
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	4.05"	3.65"	3.85"	3.60"
Dish No.	M6	112	116	A
S, W + D	280.5	287.7	292.4	264.1
Soil + Dish	256.2	262.0	266.5	241.7
Wt. Dish	87.8	90.7	91.2	87.9
Water	24.3	25.7	26.1	22.4
Soil	168.4	171.3	175.1	153.8
Water Content	14.4	15.0	14.8	14.5
σ_1	0	1.05	2.11	3.16
σ_{III}	3.74	8.15	8.37	11.73

University of Alberta

Proctor-Triaxial Data

Soil Sample CL 100U SG 612 TEST CM ∠ 0%

Modified Proctor Compaction

Optimum Moisture Content	16.0
To be compacted at	16.0
Allowance for evaporation	1.5
Total moisture to be added	17.5
Wt. of oven dried soil	4300
Volume of water added cc.	753

	B2 (1)	S (2)
No. of dish	136	112
Dish soil ∠ water	227.6	211.0
Dish ∠ soil	209.4	194.3
Dish	94.2	90.7
Water	18.2	16.7
Soil	110.2	103.6
Water Content dry wt.	16.5	16.1
Proctor cyl. ∠ wet soil	4105	3739
Proctor cylinder	2150	1742
Wet soil	1955	1997
Dry soil	1678	1718
Equivalent Sp. Gr.	1.775	1.780
Dry Density	111.0	111.1

Machine Number	1	
Pressure Medium	Air	
Wt. of piston ∠ head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	111	#/Cu.Ft.
Water content	16.3	%
∅	38.8°	
c	0.91	tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9990	9920	9670	
20	9960	9830	9650	
50	9940	9800	9530	
100	9880	9720	9475	
200	9640	9485	9280	
300	9380	9190	9000	
400	9080	8820	8590	
500	8790	8430	8200	
600	8480	8040	7890	
700	8020	7710	7430	
800	7560	7395	7080	
900		7100	6670	
1000		6795	6210	
1100		6490	5770	
1200		6160	5330	
1300		5840	4610	
1400		5440	3900	
1500		5010	2810	
1600		4460		
1700		3720		
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.50"	3.60"	3.75"	
Dish No.	125	116	M7	
S, W ∠ D	273.4	276.3	289.8	
Soil ∠ Dish	249.6	250.7	262.2	
Wt. Dish	94.5	91.2	95.2	
Water	23.8	25.6	27.6	
Soil	155.1	159.5	167.0	
Water Content	15.8	16.1	16.5	
σ_1	0	1.05	2.11	
σ_{III}	3.84	8.27	8.39	

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Proctor-Triaxial Data

Soil Sample QL 100U SG 612 TEST CM ∠ 2%

Modified Proctor Compaction

Optimum Moisture Content		~~16.0~~
To be compacted at		~~18.0~~
Allowance for evaporation		~~1.5~~
Total moisture to be added		~~19.5~~
Wt. of oven dried soil		~~4500~~
Volume of water added cc.		~~840~~
	(1) B	(2) S
No. of dish	~~M 17~~	~~M 7~~
Dish soil ∠ water	~~253.8~~	~~238.2~~
Dish ∠ soil	~~228.8~~	~~215.7~~
Dish	~~89.7~~	~~95.2~~
Water	~~25.0~~	~~22.5~~
Soil	~~139.1~~	~~120.5~~
Water Content dry wt.	~~18.0~~	~~18.6~~
Proctor cyl. ∠ wet soil	~~4032~~	~~5707~~
Proctor cylinder	~~2152~~	~~1742~~
Wet soil	~~1960~~	~~1965~~
Dry soil	~~1609~~	~~1655~~
Equivalent Sp. Gr.	~~1.700~~	~~1.715~~
Dry Density	~~106.2~~	~~107.0~~

Machine Number	1
Pressure Medium	Air
Wt. of piston ∠ head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	106.6 #/Cu.Ft.
Water content	18.3 %
∅	12.1°
c	1.10 tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0				
20	9975	9490	9820	
50	9955	9410	9810	
100	9960	9329	9760	
200	9640	9000	9600	
300	9550	7920	8850	
400	7510	6770	7915	
500	6600	5690	7130	
600	5560	4700	6350	
700	4160	3600	5340	
800	----	2450	4410	
900		0900	3100	
1000		----	1100	
1100			----	
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	~~3.85"~~	~~3.85"~~	~~3.85"~~	
Dish No.	125	116	M6	
S, W ∠ D	286.1	217.3	269.2	
Soil ∠ Dish	256.7	197.6	240.6	
Wt. Dish	94.5	91.2	87.8	
Water	29.4	19.7	28.6	
Soil	162.2	106.4	152.8	
Water Content	~~18.1~~	~~18.5~~	~~18.7~~	
σ_1	0	~~1.06~~	~~2.11~~	
σ_{III}	~~2.63~~	~~4.26~~	~~5.60~~	

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Proctor-Triaxial Data

QL 100U SG 612 TEST CM ∠ 4%

Soil Sample

Modified Proctor Compaction		
Optimum Moisture Content		16.0
To be compacted at		20.0
Allowance for evaporation		1.5
Total moisture to be added		21.5
Wt. of oven dried soil		4500
Volume of water added cc.		926
	B (1)	S (2)
No. of dish	125	136
Dish soil ∠ water	242.8	254.0
Dish ∠ soil	218.0	228.1
Dish	94.5	99.2
Water	24.8	25.9
Soil	123.5	128.9
Water Content dry wt.	20.1	20.1
Proctor cyl. ∠ wet soil	3983	3670
Proctor cylinder	2132	1742
Wet soil	1851	1928
Dry soil	1541	1605
Equivalent Sp. Gr.	1.640	1.653
Dry Density	104.0	104.8

Machine Number	1
Pressure Medium	Air
Wt. of piston ∠ head	6.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	104.4 #/Cu.Ft.
Water content	20.1 %
∅	12.1 °
c	0.72 tons/ sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
	~~10035~~	~~10060~~	~~9815~~	
0	9980	9625	9800	
20	9670	9540	9755	
50	9050	9205	9545	
100	7800	8070	8430	
200	6590	7060	7590	
300	5220	6030	6360	
400	———	4730	5340	
500		———	4290	
600			2850	
700			0015	
800			———	
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	~~5.60"~~ M2	~~5.55"~~ 134	~~5.70"~~ M1	
Dish No.	275.1	275.6	274.0	
S, W ∠ D	243.7	246.0	245.8	
Soil ∠ Dish	95.2	97.2	90.7	
Wt. Dish	29.4	29.6	30.2	
Water	148.5	148.8	153.1	
Soil	19.8	19.9	19.7	
Water Content				
q_I	0	1.05	2.11	
q_{III}	1.78	3.23	5.04	

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Proctor-Triaxial Data

Soil Sample QL 100U SG 612 TEST 85% Max. Density

Modified Proctor Compaction

Optimum Moisture Content

To be compacted at	22.5
Allowance for evaporation	0
Total moisture to be added	22.5
Wt. of oven dried soil	4000
Volume of water added cc.	900

	(1)	(2)
No. of dish	100 A	M 19
Dish soil + water	192.41	268.98
Dish + soil	178.40	236.13
Dish	86.51	88.66
Water	20.01	32.85
Soil	91.89	147.47
Water Content dry wt.	25.3	22.2
Proctor cyl. + wet soil	3609	3994
Proctor cylinder	1759	2150
Wet soil	1870	1844
Dry soil	1518	1510
Equivalent Sp. Gr.	1.599	1.590
Dry Density	99.4	99.4

Machine Number 1
Pressure Medium Air
Wt. of piston + head 0.407 Kg.
Area of Samples 9.80 Cm^2

Dry density 99.4 #/cu.ft.
Water content 22.7 %
ϕ 5.1°
c 0.48 tons/sq.ft.

Note: Loads applied on each quarter minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9851	9544	9187	
~~20~~ 10	9805	9530	9170	
~~50~~ 20	9788	9470	9126	
~~100~~ 50	9150	8978	8990	
~~200~~ 100	7660	7500	8390	
~~300~~ 150	6060	4980	7410	
~~400~~ 200	4480	2100	6240	
~~500~~ 250	1990		4480	
~~600~~ 300			1990	
~~700~~ 350				
~~800~~ 400				
~~900~~ 450				
~~1000~~ 500				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.29"	3.61"	3.51"	
Dish No.	M 6	M 116	M 1	
S, W + D	246.78	269.86	265.63	
Soil + Dish	218.13	236.50	235.20	
Wt. Dish	87.82	91.23	90.73	
Water	28.65	33.36	30.43	
Soil	130.31	145.27	144.47	
Water Content	22.0	22.9	21.1	
σ_1	0	1.05	2.11	
σ_{III}	1.00	1.90	3.40	

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Proctor-Triaxial Data

Soil Sample QL 100 U SG 612 TEST 80% Max. Density

Modified Proctor Compaction

Optimum Moisture Content

To be compacted at	27.0
Allowance for evaporation	1.5.
Total moisture to be added	28.5
Wt. of oven dried soil	4000
Volume of water added cc.	1140

	(1)	(2)
No. of dish	114	141
Dish soil + water	263.84	361.80
Dish + soil	226.43	305.26
Dish	91.24	101.41
Water	37.41	56.54
Soil	135.19	203.85
Water Content dry wt.	27.6	27.7
Proctor cyl. + wet soil	3904	3541
Proctor cylinder	2150	1739
Wet soil	1754	1802
Dry soil	1376	1412
Equivalent Sp. Gr.	1.446	1.479
Dry Density	90.5	92.5

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.00 Cm^2
Dry density	91.5 #/cu.ft.
Water content	27.6 %
∅	0 °
c	0.15 tons/sq.ft.

Note: Loads applied on each quarter minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9684	9817	9870	
~~20~~ 10	9553	9580	9829	
~~50~~ 20	8950	9025	9600	
~~100~~ 50	6220	5690	7320	
~~200~~ 100				
~~300~~ 150				
~~400~~ 200				
~~500~~ 250				
~~600~~ 300				
~~700~~ 350				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.40"	3.80"	3.45"	
Dish No.	W1 6	W19	17A	
S, W + D	243.63	249.16	247.78	
Soil + Dish	210.21	214.30	213.36	
Wt. Dish	30.73	88.66	86.21	
Water	32.82	34.86	34.42	
Soil	180.08	125.64	127.17	
Water Content	27.3	27.6	27.1	
σ_1	0	1.09	2.11	
σ_{III}	0.27	1.36	2.39	

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Proctor-Triaxial Data

OL 101U SG 1218 TEST CM -4%

Soil Sample

Modified Proctor Compaction		
Optimum Moisture Content		18.4
To be compacted at		14.4
Allowance for evaporation		0
Total moisture to be added		14.4
Wt. of oven dried soil		4300
Volume of water added cc.		620
	(1)	(2)
No. of dish	114	M7
Dish soil + water	279.01	290.35
Dish + soil	258.32	269.04
Dish	91.24	95.19
Water	20.69	21.31
Soil	167.08	173.85
Water Content dry wt.	12.3	12.2
Proctor cyl. + wet soil	3585	3937
Proctor cylinder	1739	2150
Wet soil	1846	1787
Dry soil	1644	1592
Equivalent Sp. Gr.	1.722	1.678
Dry Density	108	105

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	107 #/cu.ft.
Water content	12.5 %
ø	27.9 °
c	2.50 tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure	1	2	3	4
p.s.i.	0	15	30	
Applied Load gms	Dial Readings			
0	~~9751~~	~~8715~~	~~9050~~	
20	9699	8702	9050	
50	9627	8682	9039	
100	9520	8649	9032	
200	9390	8557	9017	
300	9304	8410	8981	
400	9222	8231	8918	
500	9158	8067	8824	
600	9091	7885	8724	
700	9024	7733	8623	
800	8962	7583	8501	
900	8901	7458	8411	
1000	8840	7332	8330	
1100	8737	7222	8249	
1200	8600	7117	8171	
1300	8499	7008	8021	
1400	8430	6913	7945	
1500	8364	6822	7860	
1600	8265	6722	7788	
1700	8050	6583	7695	
1800	———	6433	7623	
1900		6298	7550	
2000		6150	7441	
2100		5933	7349	
2200		5522	7250	
2300		———	7147	
2400			7030	
2500			6855	
2600			6633	
2700			———	
2800				
2900				
3000				
Length	~~3.86"~~ 140 ($\frac{1}{2}$)	~~3.79~~ 18' ($\frac{1}{2}$)	~~3.44"~~ 141($\frac{1}{2}$)	
Dish No.	226.79	219.42	208.73	
S, W + D	208.70	201.08	192.85	
Soil + Dish	57.79	47.62	50.49	
Wt. Dish	18.09	18.34	15.88	
Water	150.91	153.46	142.36	
Soil	12.0	11.9	11.2	
Water Content				
σ_1	0	1.05	2.11	
σ_{III}	8.31	11.37	14.48	
$\sigma_{III} - \sigma_1$	8.31	10.32	12.37	

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Proctor-Triaxial Data

Soil Sample QL 101U SG 1218 TEST OM -2%

Modified Proctor Compaction		
Optimum Moisture Content		18.4
To be compacted at		16.4
Allowance for evaporation		1.5
Total moisture to be added		17.9
Wt. of oven dried soil		4300
Volume of water added cc.		770
	B2 (1)	S (2)
No. of dish	M 19	f
Dish soil + water	224.4	211.3
Dish + soil	205.4	194.8
Dish	88.7	93.3
Water	19.0	16.5
Soil	116.7	101.5
Water Content dry wt.	16.3	16.3
Proctor cyl.+ wet soil	3920	3625
Proctor cylinder	2150	1742
Wet soil	1770	1883
Dry soil	1522	1618
Equivalent Sp. Gr.	1.610	1.678
Dry Density	101.0	104.0

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	102.5	#/cu.ft.
Water content	16.3	%
ϕ	12.9	°
c	3.19	tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9900	9770	9780	
20	9880	9760	9770	
50	9820	9745	9720	
100	9780	9710	9625	
200	9700	9650	9370	
300	9615	9580	9080	
400	9530	9500	8810	
500	9460	9435	8510	
600	9380	9350	8260	
700	9305	9265	8040	
800	9225	9160	7860	
900	9150	9050	7670	
1000	9065	8930	7490	
1100	8980	8790	7280	
1200	8880	8650	7060	
1300	8780	8410	6840	
1400	8630	8170	6630	
1500	8470	7900	6370	
1600	8200	7550	6100	
1700	———	7100	5730	
1800		6450	5270	
1900		———	4350	
2000			———	
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.80"	3.70"	3.85"	
Dish No.	74A	8	109	
S, W + D	222.6	259.8	270.1	
Soil + Dish	202.6	234.7	244.6	
Wt. Dish	78.0	81.9	89.4	
Water	20.0	25.1	25.5	
Soil	124.6	152.8	155.2	
Water Content	16.1	16.4	16.4	
σ_1	0	1.05	2.11	
σ_{III}	7.85	9.95	10.46	
$(\sigma_{III} - \sigma_1)$	7.85	8.90	8.35	

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Proctor-Triaxial Data

Soil Sample CL 101U SG 1218 TEST CM 40%

Modified Proctor Compaction		
Optimum Moisture Content	18.4	
To be compacted at	18.4	
Allowance for evaporation	1.0	
Total moisture to be added	19.4	
Wt. of oven dried soil	4300	
Volume of water added cc.	835	
	(1)	(2)
No. of dish	131	
Dish soil + water	282.60	
Dish + soil	255.42	
Dish	96.36	
Water	29.18	
Soil	157.06	
Water Content dry wt.	18.6	
Proctor cyl. + wet soil	3598	3912
Proctor cylinder	1742	2132
Wet soil	1856	1780
Dry soil	1563	1502
Equivalent Sp. Gr.	1.620	1.595
Dry Density	100.8	99.6

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	100.2	#/cu.ft.
Water content	18.6	%
ø	34.8	°
c	1.40	tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9745	9515	9820	
20	9705	9485	9780	
50	9670	9450	9720	
100	9540	9350	9700	
200	9405	9105	9665	
300	9295	8770	9615	
400	9160	8400		
500	9025	8060	9510	
600	8880	7730	9450	
700	8705	7450		
800	8480	7145	9270	
900	8245	6865		
1000	7420	6570	9080	
1100	7000	6510		
1200	———	5995	8790	
1300		5720	8590	
1400		5420	8300	
1500		5090	7700	
1600		4860	7120	
1700		3980	6060	
1800		3300	———	
1900		2500		
2000		1500		
2100		———		
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.90"	3.85"	3.80"	
Dish No.	131	f	6	
S, W + D	282.60	274.16	264.22	
Soil + Dish	255.42	245.90	236.65	
Wt. Dish	96.4	95.3	81.9	
Water	29.8	28.3	27.5	
Soil	157.0	158.6	154.8	
Water Content	18.6	18.6	17.8	
σ_1	0	1.05	2.11	
σ_{III}	5.32	9.01	9.94	
$(\sigma_{III} - \sigma_I)$	5.32	7.96	7.83	

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Proctor-Triaxial Data

Soil Sample CL 101U SG 1218 TEST OM + 2%

Modified Proctor Compaction		
Optimum Moisture Content		18.4
To be compacted at		20.4
Allowance for evaporation		1.5
Total moisture to be added		21.9
Wt. of oven dried soil		4300
Volume of water added cc.		942
	B2 (1)	S (2)
No. of dish	111	M 1
Dish soil + water	205.5	213.5
Dish + soil	186.2	189.7
Dish	90.7	90.7
Water	19.3	23.8
Soil	95.5	109.00
Water Content dry wt.	20.2	21.8
Proctor cyl.+ wet soil	4042	3661
Proctor cylinder	2150	1742
Wet soil	1892	1919
Dry soil	1573	1573
Equivalent Sp. Gr.	1.660	1.650
Dry Density	103.8	103.0

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	103.4 #/cu.ft.
Water content	21.0 %
Ø	12.0 °
c	1.40 tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure	1	2	3	4
p.s.i.	0	15	30	
Applied Load gms	Dial Readings			
0	9915	9970	9880	
20	9900	9940	9820	
50	9860	9920	9800	
100	9780	9880	9750	
200	9570	9740	9660	
300	9305	9470	9490	
400	8980	9010	9290	
500	8620	8400	9000	
600	8140	7700	8650	
700	7490	6810	8180	
800	———	5100	7620	
900		———	6830	
1000			5120	
1100			———	
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.70	3.70"	3.70"	
Dish No.	53A	114	124	
S, W + D	284.5	274.3	280.8	
Soil + Dish	252.4	241.6	248.0	
Wt. Dish	100.9	91.2	94.1	
Water	32.1	32.7	32.8	
Soil	151.5	150.4	153.9	
Water Content	21.2	21.8	21.3	
σ_1	0	1.05	2.11	
σ_{III}	3.38	4.63	6.59	
$\sigma_1 - \sigma_3$	3.38	3.53	4.48	

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Proctor-Triaxial Data

Soil Sample CL 101U SG 1218 TEST OM ∕ 4%

Modified Proctor Compaction		
Optimum Moisture Content	18.4	
To be compacted at	24.0	
Allowance for evaporation	1.0	
Total moisture to be added	25.0	
Wt. of oven dried soil	4000	
Volume of water added cc.	1000	
	B2 (1)	S (2)
No. of dish	55	ml
Dish soil ∕ water	177.1	229.15
Dish ∕ soil	160.9	199.0
Dish	92.8	75.9
Water	16.2	30.2
Soil	68.1	123.1
Water Content dry wt.	23.9	24.5
Proctor cyl. ∕ wet soil	4000	3624
Proctor cylinder	2150	1742
Wet soil	1850	1882
Dry soil	1491	1512
Equivalent Sp. Gr.	1.578	1.568
Dry Density	98.5	98.0

Machine Number	1	
Pressure Medium	Air	
Wt. of piston ∕ head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	98.2	#/cu.ft.
Water content	24.3	%
Ø	5.4°	
c	0.88	tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure	1	2	3	4
p.s.i.	0	15	30	
Applied Load gms	Dial Readings			
0	9745	9870	9685	9950
20	9730	9855	9670	9930
50	9685	9830	9650	9920
100	9570	9690	9590	9890
200	8390	9190	9140	9810
300	6400	8550	8160	9620
400	———	7660	4930	9240
500		6300	———	8480
600		4100		7260
700		———		4910
800				———
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.90"	3.75"	3.50"	3.55"
Dish No.	17A	125	f	M19
S, W ∕ D	233.2	282.7	270.2	274.0
Soil ∕ Dish	204.1	246.4	234.5	238.6
Wt. Dish	86.2	94.5	93.4	88.7
Water	29.1	36.3	35.7	35.4
Soil	117.9	151.9	141.1	149.9
Water Content	24.6	23.9	25.2	23.7
σ_1	0	1.05	2.11	3.16
σ_{III}	1.44	3.61	3.90	6.25
$\sigma_{III} - \sigma_1$	1.44	2.56	1.79	3.09

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Proctor-Triaxial Data

Soil Sample CL 101U SG 1218 TEST 90% Max. Density

Modified Proctor Compaction

Optimum Moisture Content	
To be compacted at	28.4
Allowance for evaporation	1.0
Total moisture to be added	29.4
Wt. of oven dried soil	4000
Volume of water added cc.	1176

	(1)	(2)
No. of dish	141	M6
Dish soil + water	284.50	278.14
Dish + soil	244.45	235.26
Dish	101.41	87.82
Water	40.05	42.88
Soil	143.04	147.44
Water Content dry wt.	28.0	29.0
Proctor cyl. + wet soil	3948	3560
Proctor cylinder	2150	1739
Wet soil	1798	1821
Dry soil	1406	1412
Equivalent Sp. Gr.	1.479	1.479
Dry Density	92.5	92.5

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	92.5 #/cu.ft.
Water content	28.5 %
ø	0^o
c	0.63 tons/sq.ft.

Note: Loads applied on minute and half minute each quarter

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9853	9333	9688	
~~20~~ 10	9817	9302	9683	
~~50~~ 20	9742	9257	9659	
~~100~~ 50	9566	9150	9590	
~~200~~ 100	9040	8750	9306	
~~300~~ 150	8570	7890	8680	
~~400~~ 200	7140	6570	7740	
~~500~~ 250	6020	5080	5580	
~~600~~ 300	3100	3030	3920	
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.30"	3.48"	3.40"	
Dish No.	55	125	M19	
S, W + D	250.46	259.70	247.11	
Soil + Dish	216.52	223.10	212.70	
Wt. Dish	92.82	94.56	88.66	
Water	33.94	36.60	34.41	
Soil	123.70	128.54	124.04	
Water Content	24.4	28.5	27.8	
σ_1	0	1.06	2.11	
σ_{III}	1.25	2.34	3.41	
$\sigma_{III} - \sigma_1$	1.25	1.29	1.30	

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Proctor-Triaxial Data

Soil Sample CL 101U SG 1218 TEST 85% Max. Density

Modified Proctor Compaction

Optimum Moisture Content

To be compacted at	32.0
Allowance for evaporation	1.0
Total moisture to be added	33.0
Wt. of oven dried soil	4000
Volume of water added cc.	1320

	(1)	(2)
No. of dish	55	136
Dish soil + water	309.68	269.55
Dish + soil	257.41	227.23
Dish	92.82	99.27
Water	52.27	41.32
Soil	164.59	127.96
Water Content dry wt.	31.8	32.0
Proctor cyl.+ wet soil	3873	3509
Proctor cylinder	2150	1739
Wet soil	1723	1770
Dry soil	1309	1341
Equivalent Sp. Gr.	1.378	1.406
Dry Density	86.1	87.9

Machine Number 1
Pressure Medium Air
Wt. of piston + head 0.407 Kg.
Area of Samples 9.80 Cm^2

Dry density 87.0 #/cu.ft.
Water content 31.9 %
ϕ 0^0
c 0.34 tons/sq.ft.

Note: Loads applied on each quarter minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9564	9425	9383	9824
~~20~~ 10	8917	9404	9360	9810
~~50~~ 20	8890	9380	9308	9775
~~100~~ 50	8697	9263	9002	9581
~~200~~ 100	6830	8140	6990	8280
~~300~~ 150	3730	4980	3830	6020
400				
500				
600				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.67"	3.86"	3.51"	3.03"
Dish No.	M 7	M 6	17A	125
S, W + D	262.52	263.67	243.04	230.02
Soil + Dish	222.08	221.60	205.11	197.75
Wt. Dish	95.19	87.82	86.21	94.56
Water	40.44	42.07	37.93	32.27
Soil	126.89	133.78	118.90	103.19
Water Content	31.9	31.5	31.9	31.3
σ_I	0	1.05	2.11	3.16
σ_{III}	0.68	1.76	2.79	3.87
$\sigma_{III} - \sigma_I$	0.68	0.71	0.68	0.71

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Proctor-Triaxial Data

Soil Sample CL 101U SG 1218 TEST 80% Max. Density

Modified Proctor Compaction

Optimum Moisture Content

To be compacted at	35.5
Allowance for evaporation	1.5
Total moisture to be added	37.0
Wt. of oven dried soil	4000
Volume of water added cc.	1480

	(1)	(2)
No. of dish	141	M6
Dish soil + water	266.98	275.87
Dish + soil	222.60	226.98
Dish	101.41	87.82
Water	43.48	48.89
Soil	121.19	139.16
Water Content dry wt.	35.9	35.1
Proctor cyl. + wet soil	2803	3461
Proctor cylinder	2150	1739
Wet soil	1653	1722
Dry soil	1218	1273
Equivalent Sp. Gr.	1.283	1.318
Dry Density	80.2	82.3

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	81.2 #/cu.ft.
Water content	35.5 %
ø	0°
c	0.23 tons/sq.ft.

each quarter

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9440	8992	9507	
~~20~~ 10	9361	8958	9468	
~~50~~ 20	9130	8838	9275	
~~100~~ 50	8235	6990	8030	
~~200~~ 100	3820	1770	1550	
300				
400				
500				
600				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.89"	3.77"	3.26"	
Dish No.	55	111	17A	
S, W + D	240.03	242.50	222.86	
Soil + Dish	202.53	203.20	187.42	
Wt. Dish	92.82	90.68	86.21	
Water	37.50	39.30	35.44	
Soil	109.71	112.52	101.21	
Water Content	34.2	34.9	35.1	
σ_1	0	1.08	2.11	
σ_{III}	0.45	1.50	2.56	
$\sigma_{III} - \sigma_I$	0.45	0.45	0.45	

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Proctor-Triaxial Data

Soil Sample CL 102U SG 1218 TEST OM -4%

Modified Proctor Compaction

Optimum Moisture Content		12.4
To be compacted at		8.4
Allowance for evaporation		1.0
Total moisture to be added		9.4
Wt. of oven dried soil		4300
Volume of water added cc.		404
	(1)	(2)
No. of dish	17A	55
Dish soil + water	313.80	297.26
Dish + soil	296.70	283.96
Dish	86.21	92.22
Water	17.10	13.40
Soil	210.49	191.94
Water Content dry wt.	8.1	7.0
Proctor cyl. + wet soil	4001	3661
Proctor cylinder	2153	1739
Wet soil	1848	1922
Dry soil	1705	1795
Equivalent Sp. Gr.	1.805	1.862
Dry Density	112.2	116.5

Machine Number 1
Pressure Medium Air
Wt. of piston + head 0.407 Kgs
Area of Samples 9.00 Cm²

Dry density 114.6 #/cu.ft.
Water content 7.5 %
Ø 48.2 °
c 0.74 tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9400	9327	8868	
20	9387	9274	8743	
50	9326	9222	8703	
100	9277	9150	8575	
200	9117	8987	8432	
300	8970	8839	8295	
400	8840	8708	8160	
500	8700	8590	8009	
600	8552	8448	7854	
700	8400	8322	7704	
800		8197	7541	
900		8100	7411	
1000		7960	7262	
1100		7843	7123	
1200		7712	6945	
1300		7633	6815	
1400		7515	6670	
1500		7408	6508	
1600		7285	6333	
1700		7185	6181	
1800		7052	6027	
1900		6918	5889	
2000		6745	5702	
2100			5540	
2200			5340	
2300			5110	
2400			4740	
2500				
2600				
2700				
2800				
2900				
3000				

Length	3.70"	3.50"	3.90"	
Dish No.	141	130		
S, W + D	248.62	264.63	228.00	
Soil + Dish	238.51	253.98	214.75	
Wt. Dish	101.41	98.66	45.85	
Water	10.11	10.65	13.25	
Soil	137.10	155.32	168.90	
Water Content	7.4	6.9	7.8	
σ_1	0	1.05	2.11	
σ_{III}	3.53	10.55	13.11	

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Proctor-Triaxial Data

Soil Sample QL 102 U SG 1218 TEST OM -2%

Modified Proctor Compaction

Optimum Moisture Content		12.4
To be compacted at		10.4
Allowance for evaporation		1.0
Total moisture to be added		11.4
Wt. of oven dried soil		4800
Volume of water added cc.		491
	(1)	(2)
No. of dish	78	136
Dish soil + water	317.91	298.79
Dish + soil	306.06	291.82
Dish	87.45	99.27
Water	11.85	16.97
Soil	118.61	192.55
Water Content dry wt.	10.0	8.8
Proctor cyl. + wet soil	4093	3716
Proctor cylinder	2132	1739
Wet soil	1961	1977
Dry soil	1782	1808
Equivalent Sp. Gr.	1.888	1.872
Dry Density	118.0	117.2

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	116.	#/cu.ft.
Water content	9.6	%
ø	31.1	°
c	2.22	tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9681	9150	9138	
20	9660	9134	9080	
50	9605	9118	9064	
100	9503	9089	9031	
200	9310	9010	8934	
300	9207	8925	8809	
400	9115	8832	8695	
500	9029	8741	8570	
600	8942	8615	8449	
700	8868	8499	8340	
800	8792	8370	8217	
900	8710	8233	8118	
1000	8633	8100	8012	
1100	8548	7945	7902	
1200	8450	7803	7798	
1300	8347	7669	7682	
1400	8225	7520	7572	
1500	8080	7355	7460	
1600	7848	7160	7355	
1700	———	6980	7246	
1800		6730	7117	
1900		6510	6980	
2000		6200	6830	
2100		5780	6580	
2200		5120	6330	
2300		———	5970	
2400			5400	
2500			———	
2600				
2700				
2800				
2900				
3000				
Length	3.92"	3.88"	3.65"	
Dish No.	124	112	114	
S, W + D	302.61	295.29	284.92	
Soil + Dish	282.25	275.94	265.84	
Wt. Dish	94.11	90.72	91.24	
Water	19.76	19.35	19.08	
Soil	188.74	185.22	174.60	
Water Content	10.4	10.4	10.9	
σ_1	0	1.05	2.11	
σ_{III}	7.82	11.16	13.16	

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Proctor-Triaxial Data

Soil Sample CL 102U SG 1218 TEST CM ∠ 0%

Modified Proctor Compaction		
Optimum Moisture Content		12.4
To be compacted at		12.4
Allowance for evaporation		1.0
Total moisture to be added		13.4
Wt. of oven dried soil		4300
Volume of water added cc.		577
	(1)	(2)
No. of dish	78	124
Dish soil ∠ water	278.63	205.45
Dish ∠ soil	260.81	193.81
Dish	87.45	94.11
Water	18.03	11.64
Soil	173.16	99.70
Water Content dry wt.	10.4	11.7
Proctor cyl. ∠ wet soil	3819	4130
Proctor cylinder	1739	2132
Wet soil	2080	1998
Dry soil	1882	1791
Equivalent Sp. Gr.	1.958	1.885
Dry Density	122	118

Machine Number	1	
Pressure Medium	Air	
Wt. of piston ∠ head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	120	#/cu.ft.
Water content	11.0	%
∅	20.1	°
c	3.21	tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure	1	2	3	4
p.s.i.	0	15	30	
Applied Load gms	Dial Readings			
0	9649	9400	9251	
20	9645	9392	9251	
50	9637	9371	9216	
100	9600	9327	9193	
200	9521	9225	9128	
300	9431	9120	9048	
400	9342	9025	8950	
500	9264	8942	8853	
600	9177	8843	8721	
700	9095	8758	8592	
800	9010	8642	8440	
900	8928	8540	8296	
1000	8835	8449	8106	
1100	8722	8439	7965	
1200	8623	8240	7778	
1300	8503	8128	7565	
1400	8393	8038	7350	
1500	8282	7927	7210	
1600	8106	7806	6981	
1700	7922	7074	6805	
1800	7665	7552	6577	
1900	7245	7385	6375	
2000	———	7140	6155	
2100		6905	5920	
2200		———	5620	
2300			5200	
2400			4440	
2500			———	
2600				
2700				
2800				
2900				
3000				
Length	3.66"	3.87"	3.80"	
Dish No.	156	144	112	
S, W ∠ D	301.79	316.22	294.41	
Soil ∠ Dish	281.43	295.97	274.41	
Wt, Dish	99.22	105.75	90.68	
Water	20.36	20.25	19.91	
Soil	182.21	190.22	183.73	
Water Content	11.2	10.7	10.8	
σ_3	0	1.05	2.11	
σ_1	9.09	11.14	12.84	

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Proctor-Triaxial Data

Soil Sample CL 102U SG 1218 TEST OM ∠ 2%

Modified Proctor Compaction	
Optimum Moisture Content	12.4
To be compacted at	14.4
Allowance for evaporation	1.0
Total moisture to be added	15.4
Wt. of oven dried soil	4500
Volume of water added cc.	662

	(1)	(2)
No. of dish	M6	166 A
Dish soil ∠ water	225.53	218.56
Dish ∠ soil	208.62	202.45
Dish	87.20	86.51
Water	16.91	16.11
Soil	120.82	115.94
Water Content dry wt.	14.0	13.9
Proctor cyl. ∠ wet soil	3801	4374
Proctor cylinder	1739	2132
Wet soil	2062	2242
Dry soil	1808	1970
Equivalent Sp. Gr.	1.872	1.860
Dry Density	117	116

Machine Number	1
Pressure Medium	Air
Wt. of piston ∠ head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	116.5 #/cu.ft.
Water content	14.0 %
∅	15.7 °
c	0.95 tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure	1	2	3	4
p.s.i.	0	15	30	
Applied Load gms	Dial Readings			
0	9572	9071	9096	
20	9551	9052	9087	
50	9499	9014	9070	
100	9428	8930	9031	
200	9168	8702	8926	
300	8818	8350	8771	
400	8425	7812	8573	
500	7885	7170	8360	
600	7040	6295	8065	
700	———	5390	7758	
800		4090	7440	
900		2410	7015	
1000		———	6515	
1100			5740	
1200			4850	
1300			3230	
1400			———	
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.25"	3.50"	3.32"	
Dish No.	M 14	17A	55	
S, W ∠ D	266.49	274.50	265.92	
Soil ∠ Dish	243.88	250.40	245.82	
Wt. Dish	90.00	86.21	92.8	
Water	22.81	24.10	20.1	
Soil	153.88	164.19	153.0	
Water Content	14.7	14.7	13.2	
ϵ_1	0	1.05	2.11	
ϵ_m	2.86	4.79	7.61	

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Proctor-Triaxial Data

Soil Sample CL 102U SG 1218 TEST CM ≠ 4%

Modified Proctor Compaction

Optimum Moisture Content	12.4
To be compacted at	16.4
Allowance for evaporation	1.5
Total moisture to be added	17.9
Wt. of oven dried soil	4300
Volume of water added cc.	770

	(1)	(2)
No. of dish	116	112
Dish soil ≠ water	225.80	206.55
Dish ≠ soil	206.42	189.88
Dish	91.22	90.68
Water	19.38	16.67
Soil	115.20	99.20
Water Content dry wt.	16.0	16.7
Proctor cyl.≠ wet soil	3792	4144
Proctor cylinder	1739	2137
Wet soil	2053	2012
Dry soil	1768	1722
Equivalent Sp. Gr.	1.830	1.825
Dry Density	114	114

Machine Number	1
Pressure Medium	Air
Wt. of piston ≠ head	0.407 Kg.
Area of Samples	9.80 Cm^2

Dry density	114	#/cu.ft.
Water content	16.4	%
∅	9.6	°
c	0.3	tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9494	9584	9588	
20	9401	9488	9202	
50	9338	9447	8769	
100	9175	9331	8700	
200	8250	8750	8429	
300	7085	7640	7815	
400	6070	6290	6980	
500	4530	5000	6240	
600		3290	5250	
700		1090	4560	
800			3530	
900			2020	
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.30"	4.06"	3.37"	
Dish No.	114	141		
S. W ≠ D	297.36	320.02	238.06	
Soil ≠ Dish	268.27	288.88	213.33	
Wt. Dish	91.16	101.33	55.00	
Water	29.09	31.14	24.73	
Soil	177.11	187.55	160.33	
Water Content	16.4	16.6	15.5	
ϵ_1	0	1.05	2.11	
ϵ_m	2.26	3.91	5.23	

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Proctor-Triaxial Data

Soil Sample L 102U SG 1218 TEST 90% Max. Density

Modified Proctor Compaction		
Optimum Moisture Content		
To be compacted at		18.0
Allowance for evaporation		0.5
Total moisture to be added		18.5
Wt. of oven dried soil		4000
Volume of water added cc.		740
	(1)	(2)
No. of dish	125	111
Dish soil + water	241.50	258.46
Dish + soil	220.72	232.74
Dish	94.56	90.68
Water	20.78	25.72
Soil	126.16	142.06
Water Content dry wt.	16.5	18.1
Proctor cyl. + wet soil	4134	3721
Proctor cylinder	2153	1739
Wet soil	1981	1982
Dry soil	1700	1680
Equivalent Sp. Gr.	1.790	1.760
Dry Density	112	110

Machine Number 1

Pressure Medium Air

Wt. of piston + head 0.408 Kg.

Area of Samples 9.80 cm^2

Dry density 111 #/cu.ft.

Water content 17.3 %

ϕ 6.4°

c 0.47 tons/sq.ft.

Note: Loads applied on each quarter minute and half minute

Triaxial Compression Test				
Pressure	1	2	3	4
p.s.i.	0	15	30	
Applied Load gms	Dial Readings			
0	9505	9715	9152	
~~20~~ 10	9440	9677	9141	
~~50~~ 20	9351	9650	9131	
~~100~~ 50	9087	9538	9096	
~~200~~ 100	8198	9080	8962	
~~300~~ 150	6280	7800	8714	
~~400~~ 200	4830	6500	8320	
~~500~~ 250	1500	4900	7745	
~~600~~ 300		2920	7185	
700			6365	
800			5620	
900			4430	
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.59"	3.56"	3.59"	
Dish No.	55	136	119	
S, W + D	279.92	284.90	272.12	
Soil + Dish	251.18	256.52	247.38	
Wt. Dish	92.82	99.27	88.66	
Water	28.74	28.38	24.74	
Soil	158.36	157.25	158.72	
Water Content	18.1	18.1	15.6	
σ_1	0	1.05	2.11	
σ_{III}	1.02	2.31	4.15	

University of Alberta

Proctor-Triaxial Data

Soil Sample QL 102U SG 1218 TEST 85% Max. Density

Modified Proctor Compaction

Optimum Moisture Content		11.3
To be compacted at		21.3
Allowance for evaporation		1.5
Total moisture to be added		22.8
Wt. of oven dried soil		4000
Volume of water added cc.		912
	(1)	(2)
No. of dish	M 17	142
Dish soil + water	228.41	359.08
Dish + soil	204.74	314.50
Dish	89.76	101.65
Water	23.67	44.58
Soil	114.98	212.85
Water Content dry wt.	20.6	20.9
Proctor cyl. + wet soil	5651	4000
Proctor cylinder	1742	2150
Wet soil	1909	1850
Dry soil	1581	1530
Equivalent Sp. Gr.	1.640	1.620
Dry Density	102.5	101.1

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.20	Cm²
Dry density	101.8	#/cu.ft.
Water content	20.8	%
Ø	4.6°	
c	0.25	tons/sq.ft.

Note: Loads applied on each quarter minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9704	9500	9464	
~~20~~ 10	9724	9480	9450	
~~50~~ 20	9624	9450	9423	
~~100~~ 50	9070	9456	9240	
~~200~~ 100		9356	7300	
~~300~~ 150		9080	5400	
~~400~~ 200		5306	2200	
500				
600				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.60"	3.69"	3.53"	
Dish No.	116	134	141	
S, W + D	263.71	272.25	279.63	
Soil + Dish	234.13	240.96	248.95	
Wt, Dish	91.23	97.23	101.41	
Water	29.58	31.29	30.68	
Soil	142.90	143.73	147.54	
Water Content	20.7	21.8	20.8	
[illegible]	0	1.05	2.11	
[illegible]	0.29	1.77	3.11	

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Proctor-Triaxial Data

Soil Sample CL 102U SG 1218 TEST 85% Max. Density

Modified Proctor Compaction

Optimum Moisture Content		
To be compacted at		18.8
Allowance for evaporation		0.5
Total moisture to be added		19.3
Wt. of oven dried soil		4000
Volume of water added cc.		772
	(1)	(2)
No. of dish	M 17	109
Dish soil + water	301.72	290.04
Dish + soil	264.90	254.96
Dish	89.72	89.33
Water	36.82	35.08
Soil	175.18	165.63
Water Content dry wt.	21.0	21.2
Proctor cyl. + wet soil	3667	4017
Proctor cylinder	1742	2153
Wet soil	1925	1864
Dry soil	1590	1539
Equivalent Sp. Gr.	1.665	1.621
Dry Density	104.0	101.3

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	102.6 #/cu.ft.
Water content	21.1 %
%	4.6
	0.35 tons/sq.ft.

each quarter

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9774	9772	9602	
~~20~~ 10	9674	9682	9588	
~~50~~ 20	9608	9617	9532	
~~100~~ 50	8800	8570	9383	
~~200~~ 100	5520	4410	8790	
300			3000	
400				
500				
600				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.55"	3.98"	3.95"	
Dish No.	135($\frac{1}{2}$)	137($\frac{1}{2}$)	49	
S, W + D	235.72	247.08	247.61	
Soil + Dish	203.84	212.32	213.45	
Wt. Dish	54.41	48.60	46.70	
Water	31.88	34.56	34.16	
Soil	149.43	163.92	166.75	
Water Content	21.3	21.1	20.5	
Δ	0	1.05	2.11	
ϵ_{11}	.49	1.53	2.78	

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Proctor-Triaxial Data

Soil Sample CL 102U SG 1218 TEST 75% Max. Density

Modified Proctor Compaction

Optimum Moisture Content	11.3
To be compacted at	26.3
Allowance for evaporation	1.5
Total moisture to be added	27.8
Wt. of oven dried soil	4000
Volume of water added cc.	1112

	(1)	(2)
No. of dish		
Dish soil + water		
Dish + soil		
Dish		
Water		
Soil		
Water Content dry wt.	26.6	27.3
Proctor cyl. + wet soil	3542	3905
Proctor cylinder	1742	2150
Wet soil	1800	1755
Dry soil	1425	1378
Equivalent Sp. Gr.	1.478	1.460
Dry Density	92.3	91.2

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	91.8 #/cu.ft.
Water content	27.0 %
Ø	0.1 °
c	0.07 tons/sq.ft.

each quarter

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9435	9974	1.0041	
10	9051	9812	9904	
20	8850	9190	9630	
50		4700	7590	
100				
200				
300				
400				
500				
600				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.12"	3.70"	5.60"	
Dish No.	79A	17	17A	
S, W + D	236.32	251.37	247.40	
Soil + Dish	206.41	216.93	212.77	
Wt. Dish	97.57	87.74	86.20	
Water	29.91	34.44	34.63	
Soil	108.84	129.19	126.57	
Water Content	27.5	26.6	27.3	
	0	1.05	2.11	
	0.14	1.31	2.39	

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Proctor-Triaxial Data

Soil Sample OL 103U SG 1218 TEST OM -4%

Modified Proctor Compaction

Optimum Moisture Content	11.6
To be compacted at	7.6
Allowance for evaporation	1.0
Total moisture to be added	8.6
Wt. of oven dried soil	4300
Volume of water added cc.	370

	(½ Dish) (1)	(½ Dish) (2)
No. of dish	50A	129
Dish soil + water	210.52	195.90
Dish + soil	197.59	185.92
Dish	39.65	51.25
Water	12.93	9.98
Soil	157.94	134.57
Water Content dry wt.	8.2	7.4
Proctor cyl. + wet soil	3619	4013
Proctor cylinder	1739	2153
Wet soil	1880	1860
Dry soil	1740	1730
Equivalent Sp. Gr.	1.822	1.822
Dry Density	114	114

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	2.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	114	#/Cu.Ft.
Water content	7.8	%
∅	46.6°	
c	1.14	Tons/Sq.Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 — 0	2 — 15	3 — 30	4
Applied Load gms	Dial Readings			
0	9712	1.0082	9429	
20	9665	9556	9325	
50	9630	9550	9272	
100	9590	9505	9251	
200	9552	9395	9223	
300	9478	9308	9178	
400	9423	9233	9112	
500	9370	9167	9049	
600	9321	9095	8970	
700	9270	9039	8878	
800	9220	8979	8780	
900	9158	8920	8685	
1000	9080	8860	8596	
1100	8920	8790	8490	
1200	———	8731	8387	
1300		8672	8288	
1400		8612	8190	
1500		8565	8109	
1600		8486	7990	
1700		8433	7875	
1800		8354	7732	
1900		8290	7612	
2000		8212	7442	
2100		8125	7297	
2200		8096	7115	
2300		7820	6950	
2400		———	6655	
2500			6330	
2600			———	
2700				
2800				
2900				
3000				
Length	3.52"	2.75"	3.02"	
Dish No. (½)	54A	17A	57	
S, W + D	228.22	221.31	187.15	
Soil + Dish	215.10	211.39	176.26	
Wt. Dish	45.22	86.21	38.32	
Water	13.12	9.92	10.89	
Soil	169.88	125.18	137.94	
Water Content	7.75	7.9	7.9	
σ_1	0	1.05	2.11	
σ_{III}	5.54	12.11	13.65	

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Proctor-Triaxial Data

Soil Sample CL 103U SG 1218 TEST CM -2%

Modified Proctor Compaction

Optimum Moisture Content	11.6
To be compacted at	9.6
Allowance for evaporation	1.0
Total moisture to be added	10.6
Wt. of oven dried soil	4300
Volume of water added cc.	456

	(1)	(2)
No. of dish	55	17A
Dish soil + water	258.86	239.82
Dish + soil	244.86	225.90
Dish	92.82	86.21
Water	14.00	13.92
Soil	152.04	139.69
Water Content dry wt.	9.21	10.0
Proctor cyl. + wet soil	3883	4049
Proctor cylinder	1742	2132
Wet soil	1941	1917
Dry soil	1775	1743
Equivalent Sp. Gr.	1.852	1.845
Dry Density	115.8	115.0

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	115.4	#/Cu.Ft.
Water content	9.6	%
ϕ	26.6°	
c	2.40	Tons/Sq.Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9322	9041	8858	
20	9311	9015	8854	
50	9181	8996	8850	
100	9136	8961	8845	
200	9054	8883	8825	
300	8949	8810	8800	
400	8874	8736	8758	
500	8802	8665	8703	
600	8734	8600	8634	
700	8685	8521	8567	
800	8629	8434	8480	
900	8581	8352	8414	
1000	8522	8259	8340	
1100	8462	8131	8270	
1200	8408	8019	8180	
1300	8344	7900	8098	
1400	8273	7772	8022	
1500	8172	7620	7922	
1600	———	7455	7795	
1700		7160	7665	
1800		6420	7495	
1900		———	7310	
2000			7125	
2100			6825	
2200			6460	
2300			5800	
2400			———	
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.48"	3.68"	3.92"	
Dish No.	134	114	130	
S, W + D	280.18	281.40	296.82	
Soil + Dish	265.12	264.42	278.02	
Wt. Dish	97.21	91.16	93.72	
Water	15.01	16.98	18.80	
Soil	167.91	173.26	184.30	
Water Content	9.0	9.7	10.2	
σ_1	0	1.05	2.11	
σ_{III}	7.46	9.64	12.95	

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Proctor-Triaxial Data

Soil Sample QL 103U SG 1218 TEST CM ∠ 0%

Modified Proctor Compaction

Optimum Moisture Content		11.6
To be compacted at		11.6
Allowance for evaporation		1.0
Total moisture to be added		12.6
Wt. of oven dried soil		4500
Volume of water added cc.		542
	(1)	(2)
No. of dish	112	124
Dish soil ∠ water	206.08	255.92
Dish ∠ soil	194.24	240.86
Dish	90.72	94.11
Water	11.84	15.06
Soil	103.52	146.75
Water Content dry wt.	11.4	10.3
Proctor cyl. ∠ wet soil	3745	4067
Proctor cylinder	1742	2132
Wet soil	2003	1935
Dry soil	1798	1755
Equivalent Sp. Gr.	1.962	1.858
Dry Density	116.5	116.0

Machine Number	1	
Pressure Medium	Air	
Wt. of piston ∠ head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	116.2	#/Cu.Ft.
Water content	10.8	%
	33.9	°
	2.00	Tons/Sq.Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0				
20	9365	9982	8770	9095
50	9345	9978	8754	9087
100	9322	9969	8741	9069
200	9262	9956	8706	9029
300	9184	9912	8612	8922
400	9110	9859	8494	8761
500	9049	9803	8475	8585
600	8988	9754	8248	8365
700	8921	9701	8097	8095
800	8862	9654	7942	7820
900	8805	9603	7863	7540
1000	8747	9552	7590	7262
1100	8673	9504	7555	6920
1200	8600	9443	7038	6430
1300	8520	9380	6605	5990
1400	8459	9311	———	5380
1500	8337	9239		4720
1600	8254	9169		———
1700	———	9070		
1800		8970		
1900		8832		
2000		8664		
2100		8435		
2200		———		
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length				
Dish No.	3.59"	3.99"	3.77"	3.76"
S, W ∠ D	78	134	136	142
Soil ∠ Dish	273.53	308.29	307.24	301.57
Wt. Dish	257.99	290.40	286.84	280.41
Water	87.45	97.21	99.22	101.61
Soil	15.54	17.89	20.40	21.16
Water Content	170.54	193.19	187.62	178.80
σ_1	8.9	9.3	10.9	11.8
σ_{III}	0	1.05	2.11	2.11
			6.86	8.45
	7.45	10.91	8.11	8.11

University of Alberta
Proctor-Triaxial Data

Soil Sample QL 103U SG 1218 . TEST CM ∠ 2%

Modified Proctor Compaction

Optimum Moisture Content	11.6
To be compacted at	13.6
Allowance for evaporation	1.0
Total moisture to be added	14.6
Wt. of oven dried soil	4300
Volume of water added cc.	628

	(1)	(2)
No. of dish	141	112
Dish soil ∠ water	257.32	209.85
Dish ∠ soil	238.33	103.62
Dish	101.25	90.72
Water	18.99	16.23
Soil	137.08	119.13
Water Content dry wt.	13.9	13.6
Proctor cyl. ∠ wet soil	3977	4102
Proctor cylinder	1942	2132
Wet soil	2035	1970
Dry soil	1785	1735
Equivalent Sp. Gr.	1.850	1.838
Dry Density	115.6	114.8

Machine Number	1
Pressure Medium	Air
Wt. of piston ∠ head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	107 #/Cu.Ft.
Water content	13.7 %
	17.9 °
	1.54 Tons/Sq.Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9018	9482	9685	9328
20	9018	9468	9675	9230
50	8991	9450	9661	9128
100	8883	9400	9638	9070
200	8585	9249	9557	8982
300	8068	9032	9364	8878
400	7563	8748	9139	8741
500	7005	8370	8862	8599
600	6513	7975	8530	8410
700	5920	7380	8105	8200
800	5555	6652	7545	7982
900	4420	5700	6820	7765
1000			5530	7440
1100				7130
1200				6795
1300				6435
1400				5520
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.86"	3.70"	3.66"	3.09"
Dish No.		116		142
S, W ∠ D	251.32	291.16	249.23	277.61
Soil ∠ Dish	226.67	267.00	225.78	256.96
Wt. Dish	47.06	91.22	52.02	101.61
Water	24.65	24.16	23.45	20.65
Soil	179.61	175.78	173.76	155.35
Water Content	13.7	13.7	13.5	13.3
σ_1	0	1.05	2.11	3.16
σ_{III}	4.08	5.20	6.68	9.97

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Proctor-Triaxial Data

Soil Sample QL 103U SG 1218 TEST CM ∠ 4%

Modified Proctor Compaction

ptimum Moisture Content	11.6
o be compacted at	15.6
llowance for evaporation	1.5
otal moisture to be added	17.1
t. of oven dried soil	4300
olume of water added cc.	736

	(1)	(2)
o. of dish	M 17	A 19
ish soil ∠ water	252.57	226.55
ish ∠ soil	229.64	208.05
ish	89.76	87.87
ater	22.93	18.50
oil	139.88	120.18
ater Content dry wt.	16.4	15.4
roctor cyl. ∠ wet soil	3793	4157
roctor cylinder	1739	2137
et soil	2054	2025
y soil	1761	1755
quivalent Sp. Gr.	1.840	1.848
y Density	114.8	115.5

chine Number	1
essure Medium	Air
. of piston ∠ head	0.407 Kg.
ea of Samples	9.80 Cm^2
y density	110.8 #/Cu.Ft.
ter content	15.9 %
	21.8 °
	0.72 Tons/Sq.Ft.

te: Loads applied on minute and half minute

Triaxial Compression Test

Pressure	1	2	3	4
p.s.i.	0	15	30	
Applied Load gms	Dial Readings			
0	9291	9861	8653	
20	9191	9618	8645	
50	9120	9401	8621	
100	8880	9312	8571	
200	7970	8958	8379	
300	6600	8368	7877	
400	5260	7590	7250	
500	3120	6580	6440	
600	———	5680	5540	
700		4290	4580	
800		2590	3540	
900		———	2220	
1000			———	
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.47"	4.14"	5.76"	
Dish No.	130	124		
S, W ∠ D	275.64	316.23	251.33	
Soil ∠ Dish	250.74	288.60	225.32	
Wt. Dish	98.72	94.11	39.65	
Water	24.90	27.63	26.01	
Soil	157.02	194.49	185.67	
Water Content	15.9	14.2	14.0	
σ_1	0	1.05	2.11	
σ_{III}	2.11	4.45	5.95	

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Proctor-Triaxial Data

Soil Sample CL 103U SG 1218 TEST CM ∠ 6%

Modified Proctor Compaction

ptimum Moisture Content	11.6
o be compacted at	17.6
llowance for evaporation	1.0
otal moisture to be added	18.6
t. of oven dried soil	4300
olume of water added cc.	800

	(1)	(2)
o. of dish	57	75 A
ish soil ∠ water	204.13	196.01
ish ∠ soil	178.42	174.76
ish	38.27	42.99
ater	25.71	21.25
oil	140.15	131.77
ater Content dry wt.	18.3	16.2
roctor cyl. ∠ wet soil	3744	4120
roctor cylinder	1739	2137
et soil	2005	1988
y soil	1690	1718
quivalent Sp. Gr.	1.700	1.818
y Density	110.0	113.5

chine Number	1	
essure Medium	Air	
. of piston ∠ head	0.407	Kg.
ea of Samples	9.80	Cm^2
y density	111.8	#/Cu.Ft.
ter content	17.2	%

e: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9217	8874	9110	
20	9130	8841	8590	
50	8770	8580	8532	
100	7770	7490	8408	
200		4200	7890	
300			6810	
400			5330	
500			3720	
600			0090	
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.21"	3.64"	3.50"	
Dish No.	20 A	43	M8	
S, W ∠ D	208.17	239.82	231.93	
Soil ∠ Dish	182.58	210.40	206.31	
Wt. Dish	42.08	52.96	43.81	
Water	25.59	29.42	25.62	
Soil	140.50	157.44	162.50	
Water Content	18.2	18.7	15.8	
σ_1	0	1.05	2.11	
σ_{III}	0.53	2.10	4.46	

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Proctor-Triaxial Data

Soil Sample CL 103 U SG 1218 TEST 90% Max. Density

Modified Proctor Compaction		
Optimum Moisture Content		
To be compacted at		21.0
Allowance for evaporation		0
Total moisture to be added		21.0
Wt. of oven dried soil		4000
Volume of water added cc.		840
	(1)	(2)
No. of dish	142	114
Dish soil + water	226.44	297.26
Dish + soil	204.83	265.30
Dish	101.69	91.24
Water	21.61	33.96
Soil	103.14	172.06
Water Content dry wt.	21.0	19.8
Proctor cyl. + wet soil	4025	3704
Proctor cylinder	2150	1742
Wet soil	1873	1962
Dry soil	1549	1640
Equivalent Sp. Gr.	1.638	1.698
Dry Density	102	106

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	cm^2
Dry density	104	#/cu.ft.
Water content	20.4	%
	0	
	0.24	tons/sq.ft.

each quarter

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure	1	2	3	4
p.s.i.	0	15	30	
Applied Load gms	Dial Readings			
0	9467	9395	9337	
~~20~~ 10	9442	9380	9330	
~~50~~ 20	9384	9331	9258	
~~100~~ 50	8410	8858	9088	
~~200~~ 100	5240	6020	8120	
300			6340	
400			3900	
500				
600				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	5.76"	5.61	5.57	
Dish No.	18	125	124	
S, W + D	284.87	277.02	275.44	
Soil + Dish	258.34	246.57	245.28	
Wt. Dish	98.12	94.56	94.15	
Water	52.03	30.45	29.46	
Soil	154.72	152.01	151.83	
Water Content	20.6	20.1	19.4	
ϵ_1	0	1.05	2.11	
ϵ_{1-3}	0.48	1.56	3.01	

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Proctor-Triaxial Data

Soil Sample L 103U SG 1218 TEST 85% Max. Density

Modified Proctor Compaction		
ptimum Moisture Content		
o be compacted at		22.5
llowance for evaporation		1.5
otal moisture to be added		24.0
t. of oven dried soil		4000
olume of water added cc.		960
	(1)	(2)
o. of dish	125	M6
ish soil + water	307.14	308.71
ish + soil	267.45	268.00
ish	94.56	87.82
ater	39.69	40.71
oil	172.89	180.18
ater Content dry wt.	23.0	22.6
roctor cyl. + wet soil	3978	3630
roctor cylinder	2150	1739
et soil	1828	1891
ry soil	1486	1541
quivalent Sp. Gr.	1.567	1.598
ry Density	98.0	99.6

chine Number	1	
essure Medium	Air	
. of piston + head	0.407	Kg.
ea of Samples	9.80	Cm^2
y density	98.9	#/cu.ft.
ter content	22.8	%
	C^3	
	0.24	tons/sq.ft.

each quarter

te: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9760	9733	9040	9294
~~20~~ 10	9720	9718	8850	9281
~~50~~ 20	9650	9673	8250	8995
~~100~~ 50	8210	8865	6320	8005
~~200~~ 100	4080	5400		5000
300				
400				
500				
600				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.70"	4.02"	3.62"	3.00"
Dish No.	116	142		100A
S, W + D	266.32	289.98		224.83
Soil + Dish	233.53	255.22		199.52
Wt. Dish	91.23	101.69		86.51
Water	31.99	34.76		25.31
Soil	142.30	153.53		113.01
Water Content	22.3	22.6		22.4
σ_1	0	1.08		2.11
σ_{III}	0.47	1.54		2.59

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Proctor-Triaxial Data

Soil Sample L 103U SG 1218 TEST 80% Max. Density

Modified Proctor Compaction

Optimum Moisture Content	
To be compacted at	25.0
Allowance for evaporation	1.5
Total moisture to be added	26.5
Wt. of oven dried soil	4000
Volume of water added cc.	1060

	(1)	(2)
No. of dish	116	M1
Dish soil + water	335.90	323.96
Dish + soil	286.48	277.15
Dish	91.33	90.73
Water	49.42	46.81
Soil	195.25	186.42
Water Content dry wt.	25.3	25.1
Proctor cyl. + wet soil	3941	3589
Proctor cylinder	2150	1739
Wet soil	1791	1850
Dry soil	1431	1479
Equivalent Sp. Gr.	1.508	1.532
Dry Density	94.2	95.7

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	95.0 #/cu.ft.
Water content	25.2 %
ϕ	0°
c	0.13 tons/sq.ft.

Note: Loads applied on each quarter minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0				
~~20~~ 10	9612	9619	9562	
50 20	9451	9558	9532	
~~100~~ 50	8455	9240	9178	
200	4600	7120	6420	
300				
400				
500				
600				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.59"	3.95"	3.56"	
Dish No.	100A	17A	M6	
S, W + D	252.12	250.06	254.36	
Soil + Dish	218.99	217.23	220.90	
Wt. Dish	86.51	86.21	87.82	
Water	33.13	32.83	33.46	
Soil	132.48	131.02	133.08	
Water Content	25.0	25.0	25.6	
σ_1	0	1.05	2.11	
σ_{III}	0.26	1.33	2.36	

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Proctor-Triaxial Data

Soil Sample CL 104U SG 1218 TEST OM -4%

Modified Proctor Compaction		
Optimum Moisture Content	12.4	
To be compacted at	8.4	
Allowance for evaporation	1.5	
Total moisture to be added	9.9	
Wt. of oven dried soil	4300	
Volume of water added cc.	430	
	B2 (1)	S (2)
No. of dish	100A	144
Dish soil + water	188.4	228.0
Dish + soil	173.9	217.9
Dish	86.5	105.8
Water	8.5	10.1
Soil	87.4	112.1
Water Content dry wt.	9.7	9.0
Proctor cyl. + wet soil	4000	3723
Proctor cylinder	2150	1742
Wet soil	1850	1981
Dry soil	1688	1815
Equivalent Sp. Gr.	1.786	1.882
Dry Density	112.0	117.0

Machine Number	1	
Pressure Medium	Air	
A. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm²
Dry density	114.5	#/cu.ft.
Water content	9.4	%
	42.7	°
	0.97	tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9880	9565	9345	
20	9870	9555	9320	
50	9825	9530	9270	
100	9770	9425	9170	
200	9620	9140	8950	
300	9365	8860	8725	
400	8910	8600	8500	
500	8230	8410	8310	
600	7890	8160	8090	
700	7640	7960	7920	
800	7300	7800	7740	
900	6740	7630	7570	
1000	———	7460	7400	
1100		7290	7230	
1200		7150	7070	
1300		7010	6910	
1400		6880	6770	
1500		6730	6620	
1600		6570	6470	
1700		6400	6320	
1800		6230	6150	
1900		5960	5990	
2000		———	5820	
2100			5650	
2200			5280	
2300			5030	
2400			4570	
2500			———	
2600				
2700				
2800				
2900				
3000				
Length	3.30"	3.10"	3.70"	
Dish No.	134	M 17	142	
S, W + D	237.5	235.8	271.2	
Soil + Dish	225.0	224.0	257.4	
Wt. Dish	97.2	89.7	101.6	
Water	11.6	11.8	13.8	
Soil	128.7	134.3	155.8	
Water Content	9.0	8.8	8.9	
σ_1	0	1.05	2.11	
σ_{III}	4.25	4.64	13.23	

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Proctor-Triaxial Data

Soil Sample CL 104U SG 1218 TEST OM -2%

Modified Proctor Compaction

Optimum Moisture Content	12.4
To be compacted at	10.4
Allowance for evaporation	1.5
Total moisture to be added	11.9
Wt. of oven dried soil	4300
Volume of water added cc.	512

	B2 (1)	S (2)
No. of dish	M 17	78
Dish soil + water	214.1	164.7
Dish + soil	202.1	157.0
Dish	89.8	87.4
Water	12.0	7.7
Soil	112.3	69.6
Water Content dry wt.	10.7	11.0
Proctor cyl.+ wet soil	4104	3706
Proctor cylinder	2150	1742
Wet soil	1954	1964
Dry soil	1765	1771
Equivalent Sp. Gr.	1.859	1.848
Dry Density	116.1	115.5

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	115.8	#/cu.ft.
Water content	10.8	%
	34.8	°
	1.71	tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9980	9760	9775	
20	9930	9700	9765	
50	9920	9670	9730	
100	9900	9615	9650	
200	9770	9500	9370	
300	9650	9375	9080	
400	9550	9245	8800	
500	9450	9100	8550	
600	9350	8970	8310	
700	9250	8830	8050	
800	9150	8700	7860	
900	9050	8560	7600	
1000	8920	8410	7370	
1100	8785	8265	7180	
1200	8600	8105	6970	
1300	8345	7940	6800	
1400	———	7770	6640	
1500		7570	6470	
1600		7370	6280	
1700		7090	6180	
1800		———	5930	
1900			5800	
2000			5630	
2100			5480	
2200			5290	
2300			5090	
2400			4850	
2500			4590	
2600			4250	
2700			3920	
2800			3340	
2900			———	
3000				
Length	3.20"	4.00	4.00"	
Dish No.	M 8	A		
S, W + D	249.6	290.8		
Soil + Dish	234.2	271.4		
Wt. Dish	87.8	87.9		
Water	15.4	19.4		
Soil	146.4	183.5		
Water Content	10.6	10.6		
σ_1	0	1.05	2.11	
σ_{III}	6.33	9.19	14.13	

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Proctor-Triaxial Data

Soil Sample. CL 104U SG 1218 TEST CM / 0%

Modified Proctor Compaction		
Optimum Moisture Content		12.4
To be compacted at		12.4
Allowance for evaporation		1.0
Total moisture to be added		13.4
Wt. of oven dried soil		4300
Volume of water added cc.		576
	(1)	(2)
No. of dish	M 19	
Dish soil / water	292.55	
Dish / soil	270.11	
Dish	88.70	
Water	22.44	
Soil	181.44	
Water Content dry wt.	12.4	
Proctor cyl./ wet soil	4104	3759
Proctor cylinder	2152	1759
Wet soil	1972	2020
Dry soil	1751	1792
Equivalent Sp. Gr.	1.845	1.268
Dry Density	115.2	116.3

Machine Number	1
Pressure Medium	Air
No. of piston / head	0.407 Kg.
Area of Samples	9.60 Cm^2
Dry density	116.3 #/cu.ft.
Water content	12.4 %
	42.9 °
	1.10 tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9980	9930	9685	
20	9910	9835	9640	
50	9855	9805	9605	
100	9725	9200	9570	
200	9485	8925	9500	
300	8925	8605	9430	
400	8500	8290	9355	
500	7830	7890	9280	
600	7570	7590		
700	7060	7290	9080	
800	6820	7000	8980	
900	6130	6760		
1000	5670	6500	8725	
1100	5020	6100	8570	
1200		5700		
1300		5440	8416	
1400		5255		
1500		5025	8060	
1600		4750	7820	
1700		4510	7630	
1800		4235	7350	
1900		3820	6960	
2000		3390	6370	
2100		2685	5895	
2200		2390	5640	
2300			4300	
2400			2900	
2500				
2600				
2700				
2800				
2900				
3000				
Length	5.88"	5.59"	4.00"	
Dish No.	288.58	292.55	292.18	
S, W / D	265.62	270.11	269.41	
Soil / Dish	84.6	88.7	85.0	
Wt. Dish	23.0	22.4	22.8	
Water	181.0	181.4	186.4	
Soil	13.7	12.4	12.3	
Water Content				
σ_1	0	1.05	2.11	
σ_{III}	4.94	10.31	12.31	

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Proctor-Triaxial Data

Soil Sample CL 104U SC 1218 . . TEST OM ∠ 2%

Modified Proctor Compaction

Optimum Moisture Content		12.4
To be compacted at		11.4
Allowance for evaporation		1.5
Total moisture to be added		15.2
Wt. of oven dried soil		4360
Volume of water added cc.		664
	B (1)	S (2)
No. of dish	A	100
Dish soil ∠ water	211.5	207.7
Dish ∠ soil	198.1	192.9
Dish	87.2	86.5
Water	13.4	14.8
Soil	102.2	106.4
Water Content dry wt.	14.2	13.9
Proctor cyl. ∠ wet soil	4111	3832
Proctor cylinder	2132	1742
Wet soil	1979	2040
Dry soil	1731	1792
Equivalent Sp. Gr.	1.822	1.852
Dry Density	114.0	116.0

Machine Number	1	
Pressure Medium	AIR	
Wt. of piston ∠ head	0.407	Kg.
Area of Samples	9.00	Cm^2
Dry density	115.0	#/cu.ft.
Water content	14.0	%
	27.5	°
	1.00	tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 — 0	2 — 15	3 — 30	4 — 45
Applied Load gms	Dial Readings			
0	9890	9810	9820	9590
20	9860	9800	9800	9510
50	9780	9755	9760	9410
100	9560	9610	9590	9380
200	8750	8780	9340	9220
300	7770	8085	8960	9160
400	6800	7400	8390	8590
500	5980	6760	7800	8210
600	5000	6170	7200	7815
700	3730	5560	6650	7410
800		4980	5690	6830
900		4300	4870	5980
1000		3690	4250	5500
1100		2980	2650	5140
1200		1850	1560	4340
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.65"	3.40"	3.75"	3.75"
Dish No.	114	M1	111	53A
S, W ∠ D	281.5	288.4	282.9	300.7
Soil ∠ Dish	257.2	264.2	258.5	275.9
Wt. Dish	91.2	90.7	90.7	100.9
Water	24.3	24.2	24.4	24.8
Soil	166.0	173.5	167.8	175.0
Water Content	14.6	13.9	14.1	14.2
σ_1	0	1.05	2.11	3.16
σ_{III}	3.11	5.95	6.98	8.45

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Proctor-Triaxial Data

Soil Sample OL 104U SG 1818 TEST CM + 4%

Modified Proctor Compaction

Optimum Moisture Content	12.4
To be compacted at	16.4
Allowance for evaporation	1.5
Total moisture to be added	17.9
Wt. of oven dried soil	4800
Volume of water added cc.	770

	B (1)	S (2)
No. of dish	M 14	142
Dish soil + water	280.7	229.6
Dish + soil	258.2	206.2
Dish	90.2	101.6
Water	26.9	16.4
Soil	168.9	104.6
Water Content dry wt.	16.2	15.7
Proctor cyl. + wet soil	4106	3792
Proctor cylinder	2132	1742
Wet soil	1974	2050
Dry soil	1695	1771
Equivalent Sp. Gr.	1.726	1.835
Dry Density	111.6	114.0

Machine Number 1
Pressure Medium Air
Wt. of piston + head 0.407 Kg.
Area of Samples 9.80 Cm^2

Dry density 112.0 #/cu.ft.
Water content 16.1 %
ø 9.5 °
c 1.0 tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9780	9840	9930	
20	9770	9810	9910	
50	9740	9760	9880	
100	9690	9410	9800	
200	8210	8360	9590	
300	7070	7030	8590	
400	5920	5850	7690	
500	5600	4560	6960	
600	———	3000	5660	
700		0010	4550	
800		———	———	
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.70"	3.80"	3.85"	
Dish No.	100A	111	M3	
S, W + D	227.0	293.3	272.0	
Soil + Dish	259.1	284.3	264.1	
Wt. Dish	86.5	90.7	87.3	
Water	27.9	22.7	27.9	
Soil	172.6	173.9	176.3	
Water Content	16.2	16.5	15.9	
σ_1	0	1.05	2.11	
σ_{III}	2.27	3.73	5.22	

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Proctor-Triaxial Data

Soil Sample QL 104 U SG 1218 TEST 90% Max. Density

Modified Proctor Compaction

Optimum Moisture Content

To be compacted at	20.0
Allowance for evaporation	0
Total moisture to be added	20.0
Wt. of oven dried soil	4000
Volume of water added cc.	800

	(1)	(2)
No. of dish	136	M 7
Dish soil + water	287.61	303.12
Dish + soil	255.03	267.61
Dish	99.22	95.19
Water	32.58	35.51
Soil	155.81	172.42
Water Content dry wt.	20.9	20.6
Proctor cyl. + wet soil	4041	3686
Proctor cylinder	2150	1739
Wet soil	1891	1947
Dry soil	1567	1613
Equivalent Sp. Gr.	1.650	1.690
Dry Density	103	105

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	104 #/cu.ft.
Water content	20.7 %
ø	0^{o}
c	0.35 tons/sq.ft.

Note: Loads applied on each quarter minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9780	9688	8801	
~~20~~ 10	9760	9672	8765	
~~50~~ 20	9678	9633	8708	
~~100~~ 50	8745	9470	8422	
~~200~~ 100	5130	8490	6120	
~~300~~ 150		6310	3980	
~~400~~ 200				
500				
600				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.35"	3.50"	3.64"	
Dish No.	134	34(+)	40(+)	
S, W + D	264.08	219.30	218.40	
Soil + Dish	235.72	191.22	188.70	
Wt. Dish	97.23	45.78	37.70	
Water	28.36	28.08	29.70	
Soil	138.49	145.44	151.00	
Water Content	20.4	19.3	19.7	
σ_3	0	1.05	2.11	
σ_1	0.48	1.78	2.81	

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Proctor-Triaxial Data

Soil Sample QL 104U SG 1218 TEST 85% Max. Density

Modified Proctor Compaction

Optimum Moisture Content		
To be compacted at		22.5
Allowance for evaporation		1.5
Total moisture to be added		24.0
Wt. of oven dried soil		4000
Volume of water added cc.		960
	(1)	(2)
No. of dish	142	114
Dish soil + water	310.17	294.73
Dish + soil	271.83	257.53
Dish	101.69	91.24
Water	38.34	37.20
Soil	170.14	166.29
Water Content dry wt.	22.5	22.4
Proctor cyl.+ wet soil	3991	3642
Proctor cylinder	2150	1739
Wet soil	1841	1903
Dry soil	1502	1554
Equivalent Sp. Gr.	1.584	1.628
Dry Density	99.0	101.7

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	100.3 #/cu.ft.
Water content	22.5 %
ø	0^0
c	0.24 tons/sq.ft.

Note: Loads applied on each quarter minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9731	9776	9901	
10	9681	9748	9880	
20	9610	9626	9812	
50	8570	8510	9140	
100	5110	4630	5110	
200				
300				
400				
500				
600				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.39"	3.71"	3.59"	
Dish No.	111	141	M 19	
S, W + D	255.37	282.02	266.30	
Soil + Dish	225.99	249.31	233.95	
Wt. Dish	90.68	101.41	88.66	
Water	29.38	32.71	32.35	
Soil	135.31	147.90	145.29	
Water Content	21.7	22.1	22.3	
	0	1.05	2.11	
	0.48	1.53	2.59	

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Proctor-Triaxial Data

Soil Sample CL 104U SG 1218 TEST 80% Max. Density

Modified Proctor Compaction

Optimum Moisture Content		
To be compacted at		25.0
Allowance for evaporation		1.0
Total moisture to be added		26.0
Wt. of oven dried soil		4000
Volume of water added cc.		1040
	(1)	(2)
No. of dish	125	100A
Dish soil + water	334.70	315.89
Dish + soil	296.27	268.50
Dish	94.56	86.51
Water	38.43	45.38
Soil	191.71	181.99
Water Content dry wt.	25.2	24.9
Proctor cyl. + wet soil	3944	3693
Proctor cylinder	2150	1739
Wet soil	1794	1944
Dry soil	1488	1477
Equivalent Sp. Gr.	1.510	1.528
Dry Density	93.5	95.4

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	94.5 #/cu.ft.
Water content	25.0 %
ø	0°
c	0.13 tons/sq.ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9874	9612	8884	
20 10	9808	9580	8050	
50 20	9402	9412	8270	
100 50	6660	7000	5530	
200				
300				
400				
500				
600				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.36"	3.82"	3.75"	
Dish No.	114	M19	136	
S, W + D	235.69	257.08	268.23	
Soil + Dish	206.81	223.61	234.44	
Wt. Dish	91.24	88.66	99.27	
Water	28.88	33.47	33.79	
Soil	115.57	134.95	135.17	
Water Content	25.0	24.8	25.0	
σ_3	0	1.05	2.11	
σ_1	0.25	1.29	2.32	

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Proctor-Triaxial Data

Soil Sample R 3U SC 06 TEST - CM -4%

Modified Proctor Compaction

Optimum Moisture Content	25.6
To be compacted at	21.6
Allowance for evaporation	+ 1.5
Total moisture to be added	23.1
Wt. of oven dried soil	4000
Volume of water added cc.	924

	B (1)	S(2)
No. of dish	M 7	111
Dish soil + water	216.1	197.4
Dish + soil	195.2	176.8
Dish	95.2	90.7
Water	20.9	21.1
Soil	100.0	88.1
Water Content dry wt.	20.9	21.1
Proctor cyl. + wet soil	3860	3448
Proctor cylinder	2132	1739
Wet soil	1728	1709
Dry soil	1428	1408
Equivalent Sp. Gr.	1.502	1.472
Dry Density	92.7	92.0

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	92.9 #/cu ft
Water content	21.0 %
∅	34.1°
c	1.81 tons/sq ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9910	9360	9910	
20	9880	9270	9820	
50	9850	9130	8980	
100	9780	9070	8920	
200	9580	8825	8755	
300	9380	8630	8540	
400	9180	8550	8350	
500	8970	8420	8200	
600	8740	8280	8030	
700	8530	8160	7870	
800	8350	8045	7710	
900	8180	7925	7510	
1000	8020	7800	7425	
1100	7850	7660	7290	
1200	7650	7515	7180	
1300	7510	7380	7060	
1400	———	7210	6945	
1500		7040	6830	
1600		6880	6715	
1700		6575	6600	
1800		6295	6480	
1900		5800	6355	
2000		———	6210	
2100			6080	
2200			5930	
2300			5770	
2400			5570	
2500			5360	
2600			5010	
2700			———	
2800				
2900				
3000				
Length	3.55	3.80	3.70	
Dish No.	125	M 14	124	
S, W + D	252.9	254.9	255.5	
Soil + Dish	225.4	226.2	228.1	
Wt. Dish	94.5	90.0	94.1	
Water	27.5	28.7	27.4	
Soil	130.9	136.2	134.0	
Water Content	21.0	21.1	20.4	
σ_1	0	1.05	2.11	
σ_{III}	6.21	9.92	13.98	

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Proctor-Triaxial Data

Soil Sample QR 3U SG 06 TEST - OM -2%

Modified Proctor Compaction		
Optimum Moisture Content	25.6	
To be compacted at	23.6	
Allowance for evaporation	1.4	
Total moisture to be added	25.0	
Wt. of oven dried soil	4000	
Volume of water added cc.	1000	
	B(1)	S(2)
No. of dish	M 1	111
Dish soil + water	249.9	229.7
Dish + soil	219.8	203.3
Dish	90.7	90.7
Water	30.1	26.4
Soil	129.1	112.6
Water Content dry wt.	23.3	23.5
Proctor cyl.+ wet soil	3912	3528
Proctor cylinder	2132	1739
Wet soil	1780	1789
Dry soil	1445	1450
Equivalent Sp. Gr.	1.520	1.515
Dry Density	94.9	94.5

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	94.7 #/Cu. Ft.
Water content	23.4 %
ϕ	27.2°
c	1.40 tons/sq ft

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure	1	2	3	4
p.s.i.	0	15	30	45
Applied Load gms	Dial Readings			
0	9780	9995	9680	9890
20	9740	9965	9660	9815
50	9700	9910	9500	9730
100	9580	9870	9420	9650
200	9290	9010	9175	9500
300	8835	8720	8820	9250
400	8360	8430	8500	8995
500	7850	8200	8140	8700
600	7420	7960	7810	8430
700	7120	7730	7490	8180
800	6820	7500	7210	7920
900	6520	7265	6930	7760
1000	6100	6940	6650	7510
1100	———	6600	6360	7230
1200		6270	6120	6900
1300		5950	5750	6400
1400		5510	5280	5100
1500		———	———	———
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	4.00	4.00	3.90	3.85
Dish No.	M 14	142	M 6	44
S, W + D	260.6	284.3	254.9	261.5
Soil + Dish	228.3	249.0	222.6	227.1
Wt. Dish	90.0	101.6	87.8	89.8
Water	32.3	35.3	32.3	34.4
Soil	138.3	147.4	134.8	137.3
Water Content	23.3	23.9	24.0	25.0
σ_1	0	1.05	2.11	3.16
σ_{III}	4.67	7.42	8.51	9.49

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Proctor-Triaxial Data

Soil Sample OR 3U SG 06 TEST - CM ∠ 0%

Modified Proctor Compaction

Optimum Moisture Content	25.6
To be compacted at	25.6
Allowance for evaporation	1.0
Total moisture to be added	26.6
Wt. of oven dried soil	4000
Volume of water added cc.	1064

	B(1)	S(2)
No. of dish	134	142
Dish soil ∠ water	197.6	222.8
Dish ∠ soil	176.6	197.6
Dish	97.2	101.6
Water	21.0	25.2
Soil	79.4	96.0
Water Content dry wt.	26.4	26.2
Proctor cyl. ∠ wet soil	3962	3575
Proctor cylinder	2132	1739
Wet soil	1830	1736
Dry soil	1450	1450
Equivalent Sp. Gr.	1.525	1.518
Dry Density	95.2	94.8

Machine Number	1	
Pressure Medium	Air	
Wt. of piston ∠ head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	95.0	#/Cu. Ft.
Water content	26.3	%
∅	37.0°	
c	0.85	tons/sq ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9925	9870	9750	
20	9780	9670	9320	
50	9725	9590	9270	
100	9620	8860	9240	
200	9365	8560	9150	
300	8860	7850	9000	
400	8370	7250	8805	
500	7420	6720	8580	
600	6610	6320	8300	
700	5900	6000	8060	
800	———	5650	7850	
900		5400	7620	
1000		5120	7430	
1100		4780	7225	
1200		4420	7030	
1300		4110	6820	
1400		3740	6620	
1500		3240	6370	
1600		———	6030	
1700			5620	
1800			———	
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.70	3.90	3.95	
Dish No.	M 7	M 6	79 A	
S, W ∠ D	244.4	252.9	280.4	
Soil ∠ Dish	213.0	218.9	243.2	
Wt. Dish	95.2	87.8	97.5	
Water	31.4	34.0	37.2	
Soil	117.8	131.1	145.7	
Water Content	26.6	25.9	25.6	
σ_1	0	1.05	2.11	
σ_{III}	3.24	7.47	10.00	

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Proctor-Triaxial Data

Soil Sample OR 3U SE 06 TEST - OM + 2%

Modified Proctor Compaction		
Optimum Moisture Content		25.6
To be compacted at		27.6
Allowance for evaporation		0.0
Total moisture to be added		27.6
Wt. of oven dried soil		4000
Volume of water added cc.		1124
	B (1)	S (2)
No. of dish	130	134
Dish soil + water	223.2	258.4
Dish + soil	195.2	222.4
Dish	93.8	97.2
Water	28.0	36.0
Soil	101.4	125.2
Water Content dry wt.	27.6	28.7
Proctor cyl.+ wet soil	3928	3584
Proctor cylinder	2132	1739
Wet soil	1796	1845
Dry soil	1408	1435
Equivalent Sp. Gr.	1.492	1.521
Dry Density	93.1	94.8

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	94.0	#/Cu. Ft.
Water content	28.1	%
ø	7.6°	
c	1.10	tons/sq ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure	1	2	3	4
p.s.i.	0	15	30	
Applied Load gms	Dial Readings			
0	8950	9530	9625	
20	8940	9390	9590	
50	8915	9330	9550	
100	8840	9260	9465	
200	8540	8470	9100	
300	8095	7650	8370	
400	7460	6930	7400	
500	6720	6200	6590	
600	—	5260	5100	
700		—	—	
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.95	3.85	4.00	
Dish No.	53 A	55	78	
S, W + D	289.3	263.2	275.7	
Soil + Dish	248.2	226.2	234.7	
Wt. Dish	100.4	92.8	87.4	
Water	41.1	37.0	41.0	
Soil	147.3	133.4	147.3	
Water Content	27.9	27.7	27.8	
σ_1	0	1.05	2.11	
σ_{III}	2.45	3.82	4.88	

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Proctor-Triaxial Data

Soil Sample CR 3U SG 06 TEST - OM ≠ 4%

Modified Proctor Compaction

Optimum Moisture Content	25.6	
To be compacted at	29.6	
Allowance for evaporation	0	
Total moisture to be added	29.6	
Wt. of oven dried soil	4000	
Volume of water added cc.	1185	
	B (1)	S (2)
No. of dish	M 7	121
Dish soil ≠ water	256.6	180.7
Dish ≠ soil	218.1	159.85
Dish	95.19	92.32
Water	37.5	20.85
Soil	122.91	67.53
Water Content dry wt.	30.6	30.9
Proctor cyl. ≠ wet soil	3851	3504
Proctor cylinder	2132	1739
Wet soil	1719	1765
Dry soil	1315	1345
Equivalent Sp. Gr.	1.395	1.410
Dry Density	86.5	88.0

Machine Number	1	
Pressure Medium	Air	
Wt. of piston ≠ head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	87.2	#/Cu. Ft.
Water content	30.7	%
∅	25.8°	
c	0.68	tons/sq Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4 45
Applied Load gms	Dial Readings			
0	9930	9845	9890	6115
20	9815	9610	9870	5950
50	9545	9560	9850	5900
100	9510	9450	9800	5870
200	9320	9040	9690	5780
300	8920	8470	9490	5650
400	8420	7980	9240	5480
500	——	7330	8850	5250
600		6920	8310	4450
700		6060	——	4490
800		5250		3820
900		——		2720
1000				0500
1100				——
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	4.00	4.00	3.85	3.85
Dish No.	18	109	M7	130
S, W ≠ D	251.60	264.20	266.00	270.1
Soil ≠ Dish	212.80	223.69	255	228.9
Wt. Dish	87.38	89.33	90.73	93.72
Water	38.8	40.51	41.0	41.20
Soil	125.42	134.36	134.27	135.18
Water Content	30.4	30.1	30.5	30.4
σ_1	0	1.052	2.110	3.160
σ_{III}	2.01	4.71	5.07	7.54

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Proctor-Triaxial Data

Soil Sample QR 3U SG 06 TEST 85% Max. Density

Modified Proctor Compaction

Optimum Moisture Content	25.6
To be compacted at	33.0
Allowance for evaporation	1.0
Total moisture to be added	34.0
Wt. of oven dried soil	4000
Volume of water added cc.	1360

	(1)	(2)
No. of dish	125	M17
Dish soil + water	214.52	257.11
Dish + soil	182.95	215.05
Dish	94.56	89.22
Water	31.57	44.06
Soil	88.39	123.33
Water Content dry wt.	35.8	35.7
Proctor cyl. + wet soil	3825	3826
Proctor cylinder	2153	1739
Wet soil	1672	1687
Dry soil	1232	1243
Equivalent Sp. Gr.	1.297	1.303
Dry Density	81.0	81.4

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.408 Kg_2
Area of Samples	9.80 Cm^2
Dry density	81.2 #/Cu.Ft.
Water content	35.7 %
ø	13.5 °
c	0.50 Tons/Sq.Ft.

Note: Loads applied on ~~minute and half minute~~ each quarter

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9947	9335	8983	
~~20~~ 10	9919	9318	8980	
~~30~~ 20	9884	9299	8972	
~~100~~ 50	9754	9231	8914	
~~200~~ 100	9590	8920	8647	
~~300~~ 150	8790	8312	8160	
~~400~~ 200	7610	7420	7300	
~~500~~ 250	6110	6510	6290	
~~600~~ 300		5000	4650	
~~700~~ 350			2400	
~~800~~ 400				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.90"	4.03"	3.84"	
Dish No.		52a(½)		
S, W + D	172.30	220.82	168.07	
Soil + Dish	127.86	175.46	124.00	
Wt. Dish		45.22		
Water	44.44	45.30	44.07	
Soil	127.86	130.24	124.00	
Water Content	34.8	34.8	35.6	
σ_1	0	1.05	2.11	
σ_{III}	1.09	2.41	3.60	

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Proctor-Triaxial Data

Soil Sample QR 3U SG 06 TEST - 80% Max. Density

Modified Proctor Compaction

Optimum Moisture Content	
To be compacted at	39.0
Allowance for evaporation	- 0.5
Total moisture to be added	38.5
Wt. of oven dried soil	4000
Volume of water added cc.	1540

	(1)	(2)
No. of dish	54A (½)	136
Dish soil + water	256.32	259.23
Dish + soil	194.92	212.70
Dish	45.22	99.22
Water	61.40	46.53
Soil	149.70	113.48
Water Content dry wt.	41.0	41.0
Proctor cyl./ wet soil	5426	3797
Proctor cylinder	1742	2153
Wet soil	1684	1644
Dry soil	1195	1166
Equivalent Sp. Gr.	1.252	1.227
Dry Density	78.3	76.7

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	77.6	#/Cu.Ft.
Water content	41.0	%
Ø	3.1	°
c	0.35	Tons/Sq.Ft.

Note: Loads applied on ~~minute and half~~ each quarter minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9790	9551	9110	9638
~~20~~ 10	9660	9545	9078	9621
~~50~~ 20	9555	9518	9032	9600
~~100~~ 50	9200	9366	8878	9517
~~200~~ 100	8455	9140	7970	8898
~~300~~ 150	5250	5510	5970	7350
~~400~~ 200	—	—	—	4100
~~566~~ 250				—
600				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.62"	3.98"	3.70"	3.81"
Dish No.	124	144		
S, W + D	253.92	281.60	161.27	164.13
Soil + Dish	206.50	230.69	114.47	116.43
Wt. Dish	94.10	105.87		
Water	47.42	50.91	46.80	47.70
Soil	112.40	124.82	114.47	116.43
Water Content	42.1	40.7	40.9	41.0
σ_1	0	1.05	2.11	3.16
σ_{III}	.71	1.78	2.85	4.07

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Proctor-Triaxial Data

Soil Sample QR 3U SG 06 TEST 70% Max. Density

Modified Proctor Compaction

Optimum Moisture Content

To be compacted at	45.0
Allowance for evaporation	0
Total moisture to be added	45.0
Wt. of oven dried soil	4000
Volume of water added cc.	1800

	(1)	(2)
No. of dish	112	136
Dish soil / water	256.13	220.80
Dish / soil	200.06	179.32
Dish	90.72	99.27
Water	56.07	41.48
Soil	109.34	90.05
Water Content dry wt.	51.3	51.5
Proctor cyl./ wet soil	5273	3645
Proctor cylinder	1739	2150
Wet soil	1534	1495
Dry soil	1013	988
Equivalent Sp. Gr.	1.062	1.040
Dry Density	66.4	65.0

achine Number	1
ressure Medium	Air
t. of piston / head	0.407 Kg.
rea of Samples	9.80 Cm^2
ry density	65.7 #/Cu.Ft.
ater content	51.4 %
/	0.1 °
:	0.13 Tons/Sq.Ft.

te: Loads applied on minute and half minute each quarter

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9930	8937	9522	
10	9595	8555	9207	
20	8895	8120	8650	
50	3002	4800	4000	
100				
200				
300				
400				
500				
600				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.40"	3.60"	3.50"	
Dish No.	M 7	134	--	
S, W / D	211.12	223.10	--	
Soil / Dish	172.82	181.50	--	
Wt. Dish	95.49	97.23	--	
Water	38.30	41.66	--	
Soil	77.33	84.27	--	
Water Content	49.5	49.5	--	
σ_1	0	1.05	2.11	
σ_{III}	0.24	1.3.	2.36	

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Proctor-Triaxial Data

Soil Sample CR 5U SG 06 TEST - OM -4%

Modified Proctor Compaction		
Optimum Moisture Content	26.6	
To be compacted at	22.6	
Allowance for evaporation	1.0	
Total moisture to be added	23.6	
Wt. of oven dried soil	4000	
Volume of water added cc.	944	
	B (1)	S (2)
No. of dish	134	M 14
Dish soil + water	210.6	226.3
Dish + soil	190.0	202.7
Dish	97.2	90.0
Water	20.6	23.6
Soil	92.8	112.7
Water Content dry wt.	22.2	20.9
Proctor cyl. + wet soil	3858	3435
Proctor cylinder	2132	1742
Wet soil	1726	1693
Dry soil	1411	1402
Equivalent Sp. Gr.	1.485	1.460
Dry Density	92.7	91.3

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	92.0 #/ Cu. Ft.
Water content	21.5 %
ø	49.7°
c	0.50 tons/sq ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure	1	2	3	4
p.s.i.	0	15	30	
Applied Load gms	Dial Readings			
0	9960	9890	9970	
20	9930	9910	9950	
50	9865	9390	9420	
100	9710	9265	9355	
200	9170	8870	9235	
300	8100	8510	9100	
400	7280	8180	8970	
500	6820	7900	8840	
600	6420	7620	8730	
700	———	7390	8630	
800		7190	8530	
900		7010	8440	
1000		6860	8340	
1100		6710	8250	
1200		6570	8160	
1300		6440	8050	
1400		6320	7940	
1500		6190	7810	
1600		6050	7650	
1700		5880	7480	
1800		5690	7310	
1900		5490	7090	
2000		5210	6830	
2100		4810	6500	
2200		———	6100	
2300			5400	
2400			———	
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.80	3.90	3.85	
Dish No.	53 A	44	78	
S, W + D	227.1	249.0	251.3	
Soil + Dish	203.35	218.9	222.4	
Wt. Dish	100.9	85.4	87.4	
Water	23.8	30.1	28.9	
Soil	102.4	133.5	135.0	
Water Content	23.2	22.5	21.4	
σ_1	0	1.05	2.11	
σ_{III}	2.81	10.58	12.66	

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Proctor-Triaxial Data

Soil Sample QR 5U SG 06 TEST - OM -2%

Modified Proctor Compaction

Optimum Moisture Content		26.6
To be compacted at		24.6
Allowance for evaporation		1.0
Total moisture to be added		25.6
Wt. of oven dried soil		4000
Volume of water added cc.		1024
	(1)	(2)
No. of dish	M 11	
Dish soil + water	251.55	
Dish + soil	220.33	
Dish	93.3	
Water	31.2	
Soil	127.0	
Water Content dry wt.	24.6	
Proctor cyl. + wet soil	3868	3534
Proctor cylinder	2132	1742
Wet soil	1736	1792
Dry soil	1390	143?
Equivalent Sp. Gr.	1.472	1.499
Dry Density	92.0	93.6

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	92.8	#/Cu. Ft.
Water content	24.6	%
Ø	30.8°	
c	1.60	tons/sq ft

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4 0
Applied Load gms	Dial Readings			
0	9812	9200	9080	9940
20	9770	9152	9080	9910
50	9615	9120	8975	9855
100	9408	9030	8925	9750
200	9125	8805	8825	9480
300	8780	8525	8680	9225
400	8060	8235	8530	8485
460—500	6600	7940	8385	8710
600	———	7640	8205	8460
700		7390	8080	8275
800		7170	7940	8125
900		6945	7840	7965
1000		6700	7520	7505
1100		6490	7380	1150—6700
1200		6210	7160	
1300		5900	6975	———
1400		5465	6780	
1500		5060	6530	
1600		4390	6265	
1700		———	5985	
1800			5665	
1900			5420	
2000			5120	
2100			4650	
2200			———	
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.68	3.75	3.95	3.30
Dish No.	M 11	E	68 A	109
S, W + D	251.55	244.04	261.63	238.50
Soil + Dish	220.33	211.26	227.44	210.42
Wt. Dish	93.25	81.06	83.00	89.3
Water	31.2	32.7	34.2	28.1
Soil	127.0	129.4	144.4	121.1
Water Content	24.5	25.3	23.8	23.2
σ_1	0	1.05	2.11	0
σ_{III}	2.24	8.36	12.09	5.34

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Proctor-Triaxial Data

Soil Sample QR 5U SG 06 TEST - CM ∠ 0%

Modified Proctor Compaction

Optimum Moisture Content		26.6
To be compacted at		27.2
Allowance for evaporation		1.0
Total moisture to be added		28.2
Wt. of oven dried soil		4000
Volume of water added cc.		1128
	B (1)	S (2)
No. of dish	M 6	136
Dish soil ∠ water	802.8	818.6
Dish ∠ soil	178.7	188.8
Dish	87.8	99.2
Water	24.1	23.8
Soil	90.9	89.6
Water Content dry wt.	26.5	26.5
Proctor cyl. ∠ wet soil	3900	3554
Proctor cylinder	2132	1742
Wet soil	1768	1812
Dry soil	1398	1435
Equivalent Sp. Gr.	1.468	1.495
Dry Density	91.6	93.5

Machine Number	1	
Pressure Medium	Air	
Wt. of piston ∠ head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	92.5	#/Cu. Ft.
Water content	26.5	%
∅	35.7°	
c	0.80	tons/sq ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9900	9810	9730	
20	9865	9800	9720	
50	9810	9770	9700	
100	9650	9680	9650	
200	9000	9360	9490	
300	8235	8920	9270	
400	7380	8460	9060	
500	6560	8010	8840	
600	5810	7520	8595	
700	4510	7080	8380	
800		6660	8160	
900		6330	7900	
1000		6050	7660	
1100		5740	7380	
1200		5440	7130	
1300		5100	6840	
1400		4600	6590	
1500			6270	
1600			5550	
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.85	3.80	3.95	
Dish No.	M 14	53 A	142	
S, W ∠ D	264.3	264.8	280.5	
Soil ∠ Dish	226.1	230.9	243.9	
Wt. Dish	90.0	100.9	101.6	
Water	38.2	33 .9	36.6	
Soil	136.1	130.0	142.3	
Water Content	28.0	26.1	25.7	
σ_1	0	1.05	2.11	
σ_{III}	3.11	7.25	9.43	

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Proctor-Triaxial Data

Soil Sample QR 5U SG 06 TEST - OM ∠ 2%

Modified Proctor Compaction

Optimum Moisture Content	26.6
To be compacted at	30.6
Allowance for evaporation	0.0
Total moisture to be added	30.6
Wt. of oven dried soil	4000
Volume of water added cc.	1225

	B (1)	S (2)
No. of dish	M 7	121
Dish soil ∠ water	212.7	216.0
Dish ∠ soil	185.6	188.0
Dish	95.19	92.4
Water	27.1	28.0
Soil	90.4	95.6
Water Content dry wt.	30.0	29.4
Proctor cyl. ∠ wet soil	3888	3543
Proctor cylinder	2132	1739
Wet soil	1756	1804
Dry soil	1350	1390
Equivalent Sp. Gr.	1.420	1.445
Dry Density	88.6	90.4

Machine Number	1
Pressure Medium	Air
Wt. of piston ∠ head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	89.5 #/Cu. Ft.
Water content	29.7 %
∅	32.7°
c	0.85 tons/sq ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9805	9140	9750	
20	9720	9120	9660	
50	9675	9050	9435	
100	9560	8995	9310	
200	9230	8890	9210	
300	8980	8770	9080	
400	8250	8620	8900	
500	7680	8430	8670	
600	7160	8230	8400	
700	6540	8000	8070	
800		7670	7750	
900		7320	7390	
1000		6750	6990	
1100		6100	6320	
1200		5120	5630	
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.95	3.80	3.90	
Dish No.	m 1	130	134	
S, W ∠ D	272.5	276.9	281.6	
Soil ∠ Dish	230.0	234.6	239.2	
Wt. Dish	90.7	93.7	97.2	
Water	42.5	42.3	42.4	
Soil	139.3	140.9	142.0	
Water Content	30.5	30.1	29.9	
σ_1	0	1.052	2.11	
σ_{III}	3.51	6.57	7.61	

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Proctor-Triaxial Data

Soil Sample QR 5U SG 06 TEST - OM ∠ 4%

Modified Proctor Compaction		
Optimum Moisture Content		26.6
To be compacted at		32.0
Allowance for evaporation		1.0
Total moisture to be added		33.0
Wt. of oven dried soil		4000
Volume of water added cc.		1320
	B (1)	S (2)
No. of dish	M 14	78
Dish soil ∠ water	228.8	202.3
Dish ∠ soil	193.7	174.7
Dish	90.0	87.4
Water	35.1	27.6
Soil	103.7	87.3
Water Content dry wt.	33.8	31.7
Proctor cyl. ∠ wet soil	3825	3518
Proctor cylinder	2132	1742
Wet soil	1693	1776
Dry soil	1265	1348
Equivalent Sp. Gr.	1.332	1.402
Dry Density	83.3	87.6

Machine Number	1	
Pressure Medium	Air	
Wt. of piston ∠ head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	85.0	#/Cu. Ft.
Water content	32.8	%
Ø	11.4°	
c	0.80	tons/sq ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure	1	2	3	4
p.s.i.	0	15	30	
Applied Load gms	Dial Readings			
0	9920	9950	9380	
20	9905	9890	9360	
50	9880	9815	9320	
100	9800	9580	9240	
200	9340	8820	9000	
300	8510	7200	8640	
400	7540	6600	8200	
500		5740	7610	
600			6800	
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.60	3.90	3.80	
Dish No.	125	136	55	
S, W ∠ D	263.3	236.1	264.3	
Soil ∠ Dish	220.4	202.9	223.6	
Wt. Dish	94.5	99.2	92.8	
Water	42.9	33.2	40.7	
Soil	126.9	103.7	130.8	
Water Content	33.9	32.0	31.1	
σ_1	0	1.05	2.11	
σ_{III}	1.95	3.36	5.01	

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Proctor-Triaxial Data

Soil Sample QR 5U SG 06 TEST 85% Max. Density

Modified Proctor Compaction

Optimum Moisture Content		25.6
To be compacted at		35.5
Allowance for evaporation		1.0
Total moisture to be added		36.5
Wt. of oven dried soil		4000
Volume of water added cc.		1460
	(1)	(2)
No. of dish	125	M 17
Dish soil + water	200.26	214.83
Dish + soil	170.98	178.22
Dish	94.56	89.72
Water	29.28	36.61
Soil	76.42	88.50
Water Content dry wt.	38.4	41.3
Proctor cyl. + wet soil	3795	3378
Proctor cylinder	2153	1742
Wet soil	1642	1636
Dry soil	1187	1158
Equivalent Sp. Gr.	1.250	1.213
Dry Density	78.1	75.9

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	77.0 #/cu.ft.
Water content	39.8 %
ø	2.3°
c	0.83 tons/sq.ft.

Note: Loads applied on each quarter minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	45
Applied Load gms	Dial Readings			
0	9868	8599	9683	9652
~~20~~ 10	9850	8590	9659	9643
~~50~~ 20	9828	8568	9642	9637
~~100~~ 50	9754	8495	9608	9616
~~200~~ 100	9600	8272	9500	9572
~~300~~ 150	9410	7841	9279	9500
~~400~~ 200	8955	7360	8872	9397
~~500~~ 250	8465	6540	8220	9245
~~600~~ 300	7810	6050	6980	9035
~~700~~ 350	7050	3010	5440	8625
~~800~~ 400	5610	———	2580	7920
~~900~~ 450	———		———	6300
1000				———
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.93"	3.42"	3.24"	3.65"
Dish No.	55	109	M1	17A
S, W + D	265.00	244.18	224.75	241.38
Soil + Dish	219.93	200.23	183.72	202.29
Wt. Dish	92.82	89.33	80.42	86.21
Water	45.07	43.95	41.03	39.09
Soil	127.11	110.90	103.30	116.08
Water Content	35.5	39.7	39.7	33.7
σ_1	0.	1.05	2.11	3.16
σ_{III}	1.85	2.59	3.74	5.28

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Proctor-Triaxial Data

Soil Sample QR 5J SG 06 TEST 80% Max. Density

Modified Proctor Compaction

Optimum Moisture Content		
To be compacted at		44.0
Allowance for evaporation		0
Total moisture to be added		44.0
Wt. of oven dried soil		4000
Volume of water added cc.		1760
	(1)	(2)
No. of dish	M 7	111
Dish soil + water	221.70	264.97
Dish + soil	183.78	211.20
Dish	95.18	90.68
Water	37.92	53.68
Soil	88.59	120.61
Water Content dry wt.	42.7	44.5
Proctor cyl. + wet soil	5354	5727
Proctor cylinder	1742	2150
Wet soil	1612	1577
Dry soil	1130	1092
Equivalent Sp. Gr.	1.166	1.155
Dry Density	72.7	72.2

Machine Number 1
Pressure Medium Air
Wt. of piston + head 0.407 Kg.
Area of Samples 9.80 Cm²

Dry density 72.4 #/cu.ft.
Water content 43.6 %
Ø 0.1 °
c 0.47 tons/sq.ft.

Note: Loads applied on each quarter minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9176	9397	9003	
~~20~~ 10	9160	9389	8975	
~~50~~ 20	9091	9370	8928	
~~100~~ 50	8650	9272	8840	
~~200~~ 100	8060	8490	8480	
~~300~~ 150	4970	6760	7485	
~~400~~ 200	2100	4150	6080	
~~500~~ 250			3630	
~~600~~ 300				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.31"	3.35"	3.40"	
Dish No.	114	17 A	M 19	
S, W + D	232.46	229.62	235.56	
Soil + Dish	189.73	187.00	193.40	
Wt. Dish	90.68	86.21	88.66	
Water	42.73	42.62	42.16	
Soil	99.05	100.79	104.74	
Water Content	43.1	42.2	40.2	
σ_1	0	1.05	2.11	
σ_{III}	0.84	1.95	3.22	

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Proctor-Triaxial Data

Soil Sample QR 6U SG 06 TEST CM -4%

Modified Proctor Compaction		
Optimum Moisture Content		21.5
To be compacted at		17.5
Allowance for evaporation		1.0
Total moisture to be added		18.5
Wt. of oven dried soil		4000
Volume of water added cc.		740
	(1)	(2)
No. of dish	23	
Dish soil + water	237.84	
Dish + soil	214.54	
Dish	84.60	
Water	23.30	
Soil	129.94	
Water Content dry wt.	17.9	
Proctor cyl. + wet soil	3745	3405
Proctor cylinder	2132	1739
Wet soil	1613	1666
Dry soil	1365	1412
Equivalent Sp. Gr.	1.438	1.472
Dry Density	90.0	91.9

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	91.0	#/Cu.Ft.
Water content	17.9	%
	49.3	°
	0.71	Tons/Sq.Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9618	9470	8950	
20	9522	9420	8915	
50	9452	9405	8700	
100	9245	9365	8625	
200	8880	9305	8545	
300	8475	9240	8465	
400	8195	9185	8350	
500	7910	9125	8250	
600	7587	9065	8145	
700	7250	9010		
800	6880	8940	7960	
900	———	8880		
1000		8820	7760	
1100		8700		
1200		8660	7600	
1300		8600		
1400		8540	7445	
1500		8460	7355	
1600		8395		
1700		8300	7240	
1800		8200	7135	
1900		8090		
2000		7965	7025	
2100		7650	6910	
2200		———	6815	
2300			6725	
2400			6650	
2500			6550	
2600			6450	
2700			6340	
2800			6220	
2900			6070	
3000			5770	
3100			5485	
			———	
Length	3.45"	3.60"	4.05"	
Dish No.	23	131	74A	
S, W + D	237.84	247.60	234.88	
Soil + Dish	214.54	224.31	211.03	
Wt. Dish	84.60	96.4	78.0	
Water	23.30	23.3	23.9	
Soil	129.94	127.9	133.0	
Water Content	17.9	18.2	18.0	
ϵ_1	0	1.05	2.11	
ϵ_{III}	3.84	11.28	16.61	

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Proctor-Triaxial Data

Soil Sample QR 6U SG 06 TEST OM - 2%

Modified Proctor Compaction

Optimum Moisture Content		21.5
To be compacted at		22.1
Allowance for evaporation		1.0
Total moisture to be added		23.1
Wt. of oven dried soil		4000
Volume of water added cc.		924
	(1)	(2)
No. of dish	M 17	141
Dish soil + water	289.54	276.71
Dish + soil	253.06	244.71
Dish	89.72	101.41
Water	36.48	32.00
Soil	163.34	143.30
Water Content dry wt.	22.4	22.4
Proctor cyl. + wet soil	3477	3834
Proctor cylinder	1739	2153
Wet soil	1738	1681
Dry soil	1420	1372
Equivalent Sp. Gr.	1.488	1.452
Dry Density	93.0	90.7

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	91.8	#/Cu.Ft.
Water content	22.4	%
	42.4	°
	1.60	Tons/Sq.Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9836	9790	8495	
20	9819	9762	8485	
50	9780	9729	8472	
100	9737	9669	8448	
200	9675	9528	8347	
300	9609	9355	8164	
400	9559	9185	7975	
500	9510	9016	7800	
600	9467	8958	7629	
700	9420	8787	7478	
800	9371	8543	7341	
900	9322	8416	7227	
1000	9271	8289	7112	
1100	9208	8151	7010	
1200	9150	8030	6908	
1300	9068	7909	6818	
1400	8970	7800	6731	
1500	8815	7713	6652	
1600		7592	6559	
1700		7503	6485	
1800		7376	6390	
1900		7268	6307	
2000		7154	6218	
2100		7030	6122	
2200		6886	6023	
2300		6722	5919	
2400		6480	5810	
2500			5695	
2600			5550	
2700			5395	
2800			5195	
2900			4970	
3000				
Length	3.457"	3.917"	3.623"	
Dish No.	17A	12A	125	
S, W + D	248.36	261.71	257.49	
Soil + Dish	214.69	231.61	227.52	
Wt. Dish	86.21	94.15	94.56	
Water	27.67	30.10	29.97	
Soil	128.48	137.46	132.96	
Water Content	21.6	21.9	22.6	
σ_1	0	1.05	2.11	
σ_{III}	6.98	12.53	15.52	

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Proctor-Triaxial Data

Soil Sample QR 6U SG 06 TEST CM ∠ 0%

Modified Proctor Compaction

Optimum Moisture Content		21.5
To be compacted at		20.1
Allowance for evaporation		1.0
Total moisture to be added		21.1
Wt. of oven dried soil		4000
Volume of water added cc.		844
	(1)	(2)
No. of dish	103 (½)	124
Dish soil ∠ water	207.34	251.0
Dish ∠ soil	178.54	222.22
Dish	41.67	94.15
Water	28.80	28.78
Soil	136.87	128.07
Water Content dry wt.	21.1	22.4
Proctor cyl. ∠ wet soil	3789	3421
Proctor cylinder	2153	1739
Wet soil	1636	1682
Dry soil	1351	1375
Equivalent Sp. Gr.	1.428	1.440
Dry Density	89.4	90.0

Machine Number	1	
Pressure Medium	Air	
Wt. of piston ∠ head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	89.7	#/Cu.Ft.
Water content	21.8	%
	38.3	°
	1.63	Tons/Sq. Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9509	9150	9581	
20	9489	9112	9480	
50	9425	9069	9441	
100	9352	8980	9410	
200	9223	8766	9354	
300	9117	8560	9269	
400	9023	8352	9197	
500	8940	8169	9130	
600	8848	7990	9063	
700	8760	7823	9008	
800	8654	7681	8961	
900	8561	7533	8889	
1000	8445	7402	8834	
1100	8330	7268	8767	
1200	8171	7187	8703	
1300	7935	7070	8633	
1400	———	6947	8571	
1500		6813	8498	
1600		6680	8421	
1700		6510	8327	
1800		6318	8231	
1900		6050	8139	
2000		5710	8042	
2100		———	7903	
2200			7762	
2300			7590	
2400			7380	
2500			7105	
2600			6870	
2700			6523	
2800			6265	
2900			5950	
3000			4930	
			———	

Length	3.92"	3.76"	3.32"	
Dish No.	125	M1	136	
S, W ∠ D	266.50	248.92	241.83	
Soil ∠ Dish	234.58	222.03	218.41	
Wt. Dish	94.56	90.7	99.22	
Water	31.92	26.9	23.42	
Soil	140.02	131.3	119.19	
Water Content	22.8	20.5	19.6	
σ_1	0	1.05	2.11	
σ_{III}	6.41	10.37	15.37	

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Proctor-Triaxial Data

Soil Sample QR 6U SG 06 TEST OM ∠ 2%

Modified Proctor Compaction

Optimum Moisture Content	21.5
To be compacted at	24.1
Allowance for evaporation	1.0
Total moisture to be added	25.1
Wt. of oven dried soil	4000
Volume of water added cc.	1004

	(1)	(2)
No. of dish	55	114
Dish soil ∠ water	260.79	271.72
Dish ∠ soil	226.48	235.90
Dish	92.82	91.24
Water	34.31	35.82
Soil	133.66	144.66
Water Content dry wt.	25.7	24.8
Proctor cyl. ∠ wet soil	3521	3860
Proctor cylinder	1739	2153
Wet soil	1782	1707
Dry soil	1420	1367
Equivalent Sp. Gr.	1.472	1.448
Dry Density	92.0	90.5

Machine Number	1
Pressure Medium	Air
Wt. of piston ∠ head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	91.3 #/Cu.Ft.
Water content	25.0 %
Ø	39.1 °
c	1.53 Tons/Sq.Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure	1	2	3	4
p.s.i.	0	15	30	
Applied Load gms	Dial Readings			
0	9735	9425	9275	
20	9563	9390	9263	
50	9497	9358	9251	
100	9435	9309	9219	
200	9334	9171	9153	
300	9233	9070	9036	
400	9144	8987	8902	
500	9064	8901	8762	
600	8973	8822	8645	
700	8890	8749	8458	
800	8797	8669	8283	
900	8710	8597	8140	
1000	8609	8514	8002	
1100	8487	8432	7880	
1200	8355	8347	7748	
1300	8150	8250	7625	
1400	———	8148	7497	
1500		8043	7381	
1600		7908	7248	
1700		7757	7132	
1800		7570	6979	
1900		7365	6790	
2000		7133	6548	
2100		6800	———	
2200		———		
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.31"	3.56"	3.30"	
Dish No.	17A	19A	12B	
S, W ∠ D	239.19	244.75	243.95	
Soil ∠ Dish	207.42	213.86	215.32	
Wt. Dish	86.21	87.87	94.56	
Water	31.77	30.89	28.63	
Soil	121.21	125.99	120.76	
Water Content	26.2	24.5	23.8	
σ_1	0	1.05	2.11	
σ_{III}	6.38	11.02	11.04	

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Proctor-Triaxial Data

Soil Sample QR 6U SG 06 TEST OM ∕ 4%

Modified Proctor Compaction

Optimum Moisture Content		21.5
To be compacted at		26.1
Allowance for evaporation		1.0
Total moisture to be added		27.1
Wt. of oven dried soil		4000
Volume of water added cc.		1084
	(1)	(2)
No. of dish	55	141
Dish soil ∕ water	255.93	306.56
Dish ∕ soil	221.02	259.11
Dish	92.82	101.41
Water	36.91	47.45
Soil	128.20	157.70
Water Content dry wt.	28.8	30.1
Proctor cyl. ∕ wet soil	3544	3919
Proctor cylinder	1739	2153
Wet soil	1805	1766
Dry soil	1400	1358
Equivalent Sp. Gr.	1.452	1.430
Dry Density	90.7	89.4

Machine Number	1	
Pressure Medium	Air	
Wt. of piston ∕ head	6.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	90.0	#/Cu.Ft.
Water content	29.5	%
∅	39.1	°
c	0.40	Tons/Sq.Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9869	9545	8890	
20	9838	9522	8872	
50	9759	9504	8825	
100	9594	9465	8740	
200	8985	9350	8412	
300	7950	9180	7820	
400	6800	9027	7190	
500		8853	6730	
600		8671	6155	
700		8491	5590	
800		8280	5145	
900		8057	4695	
1000		7813	4320	
1100		7420	3400	
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.95"	3.44"	3.83"	
Dish No.	12A	11A	78	
S, W ∕ D	266.76	245.42	247.91	
Soil ∕ Dish	227.49	211.50	212.18	
Wt. Dish	94.15	91.24	87.45	
Water	39.27	33.92	35.73	
Soil	133.34	120.26	124.73	
Water Content	29.4	28.2	28.6	
σ_1	0	1.05	2.11	
σ_{III}	1.92	6.35	6.94	

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Proctor-Triaxial Data

Soil Sample QR 6U SG 06 TEST 90% Max. Density

Modified Proctor Compaction		
Optimum Moisture Content		
To be compacted at	34.0	
Allowance for evaporation	0	
Total moisture to be added	34.0	
Wt. of oven dried soil	4000	
Volume of water added cc.	1360	
	(1)	(2)
No. of dish	116	1004
Dish soil + water	244.84	246.24
Dish + soil	205.24	207.26
Dish	91.23	86.51
Water	39.60	39.68
Soil	114.01	120.75
Water Content dry wt.	34.7	34.0
Proctor cyl. + wet soil	3860	3512
Proctor cylinder	2150	1739
Wet soil	1710	1773
Dry soil	1270	1322
Equivalent Sp. Gr.	1.382	1.368
Dry Density	83.2	85.3

Machine Number 1
Pressure Medium Air
Wt. of piston + head 0.107 Kg.
Area of Samples 9.30 Cm^2

Dry density 85.3 #/cu.ft.
Water content 33.3 %
ϕ 0.1 °
c 1.45 tons/sq.ft.

Note: Loads applied on ~~minute and half~~ each quarter minute

Triaxial Compression Test				
Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9800	9632	9423	
~~20~~ 10	9782	9652	9418	
~~50~~ 20	9755	9620	9409	
~~100~~ 50	9730	9590	9382	
~~200~~ 100	9671	9533	9312	
~~300~~ 150	9559	9461	9151	
~~400~~ 200	9470	9376	8940	
~~500~~ 250	9351	9266	8635	
~~600~~ 300	9219	9136	8310	
~~700~~ 350	9067	8965	7965	
~~800~~ 400	8890	8785	7575	
~~900~~ 450	8685	8518	7135	
~~1000~~ 500	8210	8228	6705	
~~1100~~ 550	7805	7845	6230	
~~1200~~ 600	7220	7240	5470	
~~1300~~ 650		5900	4100	
1400		2600		
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.50"	3.32"	3.56"	
Dish No.	124	114	M1	
S, W + D	257.10	243.84	246.51	
Soil + Dish	216.52	205.48	207.90	
Wt. Dish	94.10	91.24	90.73	
Water	40.58	38.36	38.61	
Soil	122.42	114.24	117.17	
Water Content	33.2	33.5	32.8	
σ_1	0	1.05	2.11	
σ_{III}	2.88	3.91	4.97	

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Proctor-Triaxial Data

Soil Sample QR 8U SG 06 TEST 85% Max. Density

Modified Proctor Compaction

Optimum Moisture Content

To be compacted at	33.0
Allowance for evaporation	0.0
Total moisture to be added	33.0
Wt. of oven dried soil	4000
Volume of water added cc.	1320

	(1)	(2)
No. of dish	114	144
Dish soil + water	224.62	211.41
Dish + soil	189.30	184.81
Dish	91.2	105.2
Water	35.32	26.60
Soil	98.1	79.0
Water Content dry wt.	36.0	33.7
Proctor cyl. + wet soil	5300	3711
Proctor cylinder	1742	2150
Wet soil	1558	1561
Dry soil	1143	1168
Equivalent Sp. Gr.	1.185	1.235
Dry Density	74.0	77.0

Machine Number 1
Pressure Medium Air
Wt. of piston + head 0.497 Kg.
Area of Samples 9.80 Cm²

Dry density 75.5 #/cu.ft.
Water content 34.8 %
ø 4.8 °
c 0.83 tons/sq.ft.

Note: Loads applied on each quarter minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9500	9250	9349	
~~20~~ 10	9503	9251	9338	
~~50~~ 20	9504	9210	9317	
~~100~~ 50	9497	9142	9281	
~~200~~ 100	9480	8958	9210	
~~300~~ 150	9430	8603	9102	
~~400~~ 200	9073	8140	8975	
~~500~~ 250	8832	7590	8923	
~~600~~ 300	8510	6825	8625	
~~700~~ 350	7750	5960	8358	
~~800~~ 400	———	4830	8075	
~~900~~ 450		2400	7645	
~~1000~~ 500		———	7070	
~~1100~~ 550			5890	
1200			———	
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.69"	3.75"	3.69"	
Dish No.	M 1	142	M 6	
S, W + D	244.40	261.01	241.52	
Soil + Dish	204.59	218.91	204.30	
Wt. Dish	90.7	101.6	87.0	
Water	39.81	42.10	37.22	
Soil	113.9	117.3	116.5	
Water Content	34.1	35.9	31.9	
σ_1	0	1.05	2.11	
σ_{III}	1.74	2.96	4.57	

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Proctor-Triaxial Data

Soil Sample QR 6U SG 06 TEST 80% Max. Density

Modified Proctor Compaction	
Optimum Moisture Content	22.0
To be compacted at	37.0
Allowance for evaporation	1.0
Total moisture to be added	38.0
Wt. of oven dried soil	4000
Volume of water added cc.	1520

	(1)	(2)
No. of dish	55	109
Dish soil + water	204.07	188.10
Dish + soil	172.27	162.08
Dish	92.82	89.53
Water	31.80	26.02
Soil	79.45	72.75
Water Content dry wt.	40.0	35.8
Proctor cyl. + wet soil	3291	3663
Proctor cylinder	1742	2153
Wet soil	1549	1510
Dry soil	1105	1112
Equivalent Sp. Gr.	1.145	1.170
Dry Density	71.6	73.1

Machine Number 1
Pressure Medium Air
Wt. of piston + head 0.407 Kg.
Area of Samples 9.00 Cm2

Dry density 72.3 #/cu.ft.
Water content 37.8 %
ϕ 4.9 °
c 0.37 tons/sq.ft.

Note: Loads applied on each quarter minute and half minute

Triaxial Compression Test				
Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9424	9370	8855	
~~20~~ 10	9367	9348	8825	
~~50~~ 20	9146	9315	8820	
~~100~~ 50	9013	9261	8792	
~~200~~ 100	8748	9010	8743	
~~300~~ 150	8295	8515	8655	
~~400~~ 200	7690	7530	8537	
~~500~~ 250	6250	6130	8350	
~~600~~ 300		3730	7900	
~~700~~ 350		0980	6965	
800			5370	
900			2900	
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.73"	3.65"	3.70"	
Dish No.	21	123(2)	153(2)	
S, W + D	226.01	214.71	201.49	
Soil + Dish	186.42	168.82	161.32	
Wt. Dish	80.42	55.22	54.41	
Water	39.59	46.09	40.17	
Soil	106.00	113.40	106.91	
Water Content	37.4	40.6	37.6	
σ_1	0	1.05	2.11	
σ_{III}	1.20	2.44	4.07	

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Proctor-Triaxial Data

Soil Sample CR 7U SG 06 TEST - OM -4%

Modified Proctor Compaction		
Optimum Moisture Content		28.9
To be compacted at		24.9
Allowance for evaporation		0.5
Total moisture to be added		25.4
Wt. of oven dried soil		4000
Volume of water added cc.		1016
	B (1)	S (2)
No. of dish	M 1	MF
Dish soil / water	208.0	199.5
Dish / soil	185.0	180.3
Dish	90.7	95.2
Water	23.0	19.2
Soil	94.3	85.1
Water Content dry wt.	24.4	22.6
Proctor cyl./ wet soil	3800	3480
Proctor cylinder	2132	1742
Wet soil	1668	1738
Dry soil	1338	1418
Equivalent Sp. Gr.	1.410	1.476
Dry Density	88.1	92.2

Machine Number	1	
Pressure Medium	Air	
Wt. of piston / head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	90.0	#/Cu. Ft.
Water content	23.5	%
ø	40.8°	
c	0.48	tons/sq ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9950	9915	9810	
20	9940	9900	9790	
50	9890	9805	9750	
100	9710	9670	9675	
200	8690	9300	9530	
300	7880	8940	9380	
400	7200	8640	9250	
500	———	8390	9130	
600		8170	9025	
700		7930	8915	
800		7690	8810	
900		7410	8710	
1000		7100	8620	
1100		6500	8520	
1200		———	8425	
1300			8325	
1400			8210	
1500			8080	
1600			7935	
1700			7770	
1800			7570	
1900			7350	
2000			7140	
2100			6770	
2200			6000	
2300			———	
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.90	3.75	3.65	
Dish No.	78	55	125	
S, W / D	221.6	253.9	255.6	
Soil / Dish	196.7	221.7	226.1	
Wt. Dish	87.4	84.9	94.5	
Water	24.9	32.2	29.5	
Soil	109.3	136.8	131.6	
Water Content	22.8	23.5	22.4	
σ_1	0	1.05	2.11	
σ_{III}	1.94	6.19	12.19	

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Proctor-Triaxial Data

Soil Sample CR 7U SG 06 TEST - OM -2%

Modified Proctor Compaction

Optimum Moisture Content	~~28.9~~	
To be compacted at	~~26.9~~	
Allowance for evaporation	~~- 0.5~~	
Total moisture to be added	~~26.4~~	
Wt. of oven dried soil	~~4000~~	
Volume of water added cc.	~~1056~~	

	B (1)	S (2)
No. of dish	~~134~~	~~136~~
Dish soil + water	~~197.1~~	~~225.7~~
Dish + soil	~~175.0~~	~~199.4~~
Dish	~~94.1~~	~~99.2~~
Water	~~22.1~~	~~26.3~~
Soil	~~80.9~~	~~100.2~~
Water Content dry wt.	~~27.3~~	~~26.2~~
Proctor cyl. + wet soil	~~3910~~	~~3563~~
Proctor cylinder	~~2132~~	~~1742~~
Wet soil	~~1778~~	~~1821~~
Dry soil	~~1395~~	~~1441~~
Equivalent Sp. Gr.	~~1.462~~	~~1.501~~
Dry Density	~~91.6~~	~~93.8~~

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	90.9	#/Cu. Ft.
Water content	26.8	%
ø	30.5°	
c	1.20	tons/sq ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9987	9980	10135	
20	9785	9810	10130	
50	9730	9530	9950	
100	9550	9410	9860	
200	9240	9040	9710	
300	8850	8590	9385	
400	8410	8100	9000	
500	8030	7680	8620	
600	7610	7290	8250	
700	7260	6985	7890	
800	6840	6690	7560	
900	6400	6450	7260	
1000	———	6215	7000	
1100		5930	6650	
1200		5620	6270	
1300		5280	———	
1400		4850		
1500		———		
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	4.00	3.75	3.70	
Dish No.	144	m 7	125	
S, W + D	285.8	269.9	267.2	
Soil + Dish	247.9	232.7	230.4	
Wt. Dish	103.75	95.2	94.5	
Water	37.9	37.2	36.8	
Soil	142.1	137.5	135.9	
Water Content	26.7	27.0	27.0	
σ_1	0	1.05	2.11	
σ_{III}	4.23	7.31	7.63	

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Proctor-Triaxial Data

Soil Sample QR 7U SG 06 TEST - CM ∠ 0%

Modified Proctor Compaction		
Optimum Moisture Content	28.9	
To be compacted at	28.9	
Allowance for evaporation	1.0	
Total moisture to be added	29.9	
Wt. of oven dried soil	4000	
Volume of water added cc.	1196	
	B (1)	S (2)
No. of dish	M 6	130
Dish soil ∠ water	198.1	224.3
Dish ∠ soil	173.7	195.5
Dish	87.8	93.7
Water	24.4	28.8
Soil	85.9	101.8
Water Content dry wt.	28.4	28.4
Proctor cyl. ∠ wet soil	3896	3522
Proctor cylinder	2132	1739
Wet soil	1764	1786
Dry soil	1375	1390
Equivalent Sp. Gr.	1.450	1.448
Dry Density	90.6	90.6

Machine Number	1	
Pressure Medium	Air	
Wt. of piston ∠ head	0.407	kg.
Area of Samples	9.80	Cm^2
Dry density	91.1	#/Cu. Ft.
Water content	28.4	%
∅	26.2°	
c	1.10	tons/sq ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure	1	2	3	4
p.s.i.	0	15	30	
Applied Load gms	Dial Readings			
0	10025	9745	9580	
20	9935	9410	9180	
50	9885	9305	9010	
100	9725	9190	8930	
200	9340	8880	8680	
300	8725	8410	8330	
400	8140	7990	7915	
500	7530	7530	7500	
600	6850	7070	7100	
700	6000	6610	6680	
800	4900	6170	6280	
900	———	5720	5820	
1000		5250	5300	
1100		4650	4720	
1200		3420	3950	
1300		———	2500	
1400			0300	
1500			———	
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.85	3.80	3.85	
Dish No.	M 14	M 7	124	
S, W ∠ D	260.8	265.6	262.6	
Soil ∠ Dish	224.0	227.6	225.1	
Wt. Dish	90.0	95.2	94.1	
Water	36.8	38.0	37.5	
Soil	134.0	132.4	130.0	
Water Content	27.5	28.8	28.7	
σ_1	0	1.05	2.11	
σ_{III}	3.58	6.26	7.66	

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Proctor-Triaxial Data

Soil Sample QR 7U SC 06 TEST - OM + 2%

Modified Proctor Compaction		
Optimum Moisture Content	28.9	
To be compacted at	30.9	
Allowance for evaporation	1.0	
Total moisture to be added	31.9	
Wt. of oven dried soil	4000	
Volume of water added cc.	1276	
	S (1)	(2)
No. of dish	M 11	
Dish soil + water	265.71	
Dish + soil	224.34	
Dish	93.25	
Water	41.4	
Soil	131.0	
Water Content dry wt.	31.5	
Proctor cyl. + wet soil	3502	
Proctor cylinder	1739	
Wet soil	1763	
Dry soil	1341	
Equivalent Sp. Gr.	1.425	
Dry Density	89.0	

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg
Area of Samples	9.80 Cm^2
Dry density	89.0 #/Cu. Ft.
Water content	31.5 %
ø	13.2°
c	1.02 tons/sq ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure	1	2	3	4
p.s.i.	0	15	30	
Applied Load gms	Dial Readings			
0	9805	9195	8245	
20	9750	9175	8195	
50	9690	9115	8120	
100	9485	8380	7940	
200	8870	8250	7455	
300	8260	7500	6825	
400	7325	6640	6140	
500	6365	5500	5250	
540-600	-5660	4400	4100	
700		3700	2900	
760-800		-1500	0650	
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.95	4.05	3.95	
Dish No.	M 11	F	109	
S, W + D	265.71	264.60	255.35	
Soil + Dish	224.34	223.38	215.52	
Wt. Dish	93.25	93.33	89.33	
Water	41.3	41.2	39.9	
Soil	131.0	130.1	126.2	
Water Content	31.5	31.6	31.5	
σ_1	0	1.05	2.11	
σ_{III}				

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Proctor-Triaxial Data

Soil Sample QR 7U SG 06 TEST - CM ∠ 4%

Modified Proctor Compaction		
Optimum Moisture Content		28.9
To be compacted at		30.9
Allowance for evaporation		0.0
Total moisture to be added		32.9
Wt. of oven dried soil		4000
Volume of water added cc.		1315
	B (1)	S (2)
No. of dish	79 A	M 6
Dish soil ∠ water	199.7	204.2
Dish ∠ soil	173.5	175.1
Dish	97.5	87.80
Water	26.2	29.1
Soil	76.0	87.3
Water Content dry wt.	34.5	33.4
Proctor cyl. ∠ wet soil	3818	3481
Proctor cylinder	2132	1739
Wet soil	1686	1742
Dry soil	1250	1305
Equivalent Sp. Gr.	1.318	1.350
Dry Density	82.4	84.3

Machine Number	1
Pressure Medium	Air
Wt. of piston ∠ head	0.41 Kg.
Area of Samples	4.80 Cm^2
Dry density	83.3 #/Cu. Ft.
Water content	34.0 %
∅	13.7°
c	0.82 tons/sq ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	8175	9955	9970	
20	8100	9605	9960	
50	8050	9430	9180	
100	7860	9240	9100	
200	6970	8570	8720	
300	5460	7660	7860	
400	3720	6810	6860	
500	0400	5910	5500	
600	———	4720	4330	
700		2420	2200	
800		———	———	
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.70	3.75	3.95	
Dish No.	142	134	M 7	
S, W ∠ D	263.7	264.3	265.4	
Soil ∠ Dish	222.0	222.3	222.1	
Wt. Dish	101.61	97.21	95.19	
Water	41.7	42.0	43.3	
Soil	120.4	125.1	126.9	
Water Content	34.5	33.5	34.1	
σ_1	0	1.05	2.11	
σ_{III}	2.04	3.94	5.00	

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Proctor-Triaxial Data

Soil Sample QR VU SC 06 TEST 85% Max. Density

Modified Proctor Compaction

Optimum Moisture Content	26.8
To be compacted at	36.0
Allowance for evaporation	1.0
Total moisture to be added	37.0
Wt. of oven dried soil	4000
Volume of water added cc.	1480

	(1)	(2)
No. of dish	M 19	125
Dish soil + water	196.02	224.38
Dish + soil	168.02	188.00
Dish	88.66	94.56
Water	28.00	36.38
Soil	79.36	93.44
Water Content dry wt.	35.4	38.9
Proctor cyl. + wet soil	3305	3765
Proctor cylinder	1742	2150
Wet soil	1563	1615
Dry soil	1221	1163
Equivalent Sp. Gr.	1.268	1.242
Dry Density	79.2	77.7

Machine Number 1
Pressure Medium Air
Wt. of piston + head 0.407 Kg.
Area of Samples 9.30 Cm^2

Dry density 78.4 #/Cu.Ft.
Water content 37.1 %
ϕ 3.7°
c 0.70 tons/sq.ft.

Note: Loads applied on ~~minute-and-half~~ Each quater minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9775	9589	9416	
~~20~~ 10	9680	9520	9405	
~~50~~ 20	0601	9470	9394	
~~100~~ 50	9494	9383	9358	
~~200~~ 100	9320	9080	9278	
~~300~~ 150	8940	8493	9147	
~~400~~ 200	8350	7810	8979	
~~500~~ 250	7350	6530	8729	
~~600~~ 300	5930	5230	8430	
~~700~~ 350	2700	3200	7980	
~~800~~ 400	———	0590	7400	
~~900~~ 450		———	5990	
~~1000~~ 500			4110	
~~1100~~ 550			———	
~~1200~~ 600				
~~1300~~ 650				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.49"	3.78"	3.65"	
Dish No.	144	136	124	
S, W + D	258.94	260.68	262.15	
Soil + Dish	216.42	215.30	217.50	
Wt. Dish	105.87	99.27	94.10	
Water	42.46	45.38	44.65	
Soil	110.61	116.05	123.40	
Water Content	38.4	39.1	36.1	
σ_1	0	1.05	2.11	
σ_{III}	1.46	2.64	4.33	

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Proctor-Triaxial Data

Soil Sample QR 7u SG 06 TEST 80% Max. Density

Modified Proctor Compaction

Optimum Moisture Content

To be compacted at	41.0
Allowance for evaporation	0
Total moisture to be added	41.0
Wt. of oven dried soil	4000
Volume of water added cc.	1640

	(1)	(2)
No. of dish	116	M1
Dish soil + water	279.51	211.32
Dish + soil	225.15	175.29
Dish	91.23	90.73
Water	54.36	36.03
Soil	133.42	84.56
Water Content dry wt.	40.5	42.5
Proctor cyl. + wet soil	3300	3734
Proctor cylinder	1742	2150
Wet soil	1558	1584
Dry soil	1108	1111
Equivalent Sp. Gr.	1.160	1.176
Dry Density	72.6	73.8

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	73.2 #/cu.ft.
Water content	41.5 %
ø	0 °
c	0.45 tons/sq.ft.

each quarter

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
	~~9955~~	~~9351~~	~~9935~~	
0 10	9915	9306	9924	
20 20	9824	9259	9893	
50 50	9478	9060	9783	
100 100	9245	8830	9190	
200 150	7720	4830	6820	
300 200	3220	———	5150	
400 250	———		2970	
500 300			———	
600				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	~~3.70"~~	~~3.56"~~	~~3.64"~~	
Dish No.	250.02	236.43	236.22	
S, W + D	203.63	191.60	193.75	
Soil + Dish	92.82	86.51	87.87	
Wt. Dish	46.39	44.83	42.47	
Water	110.81	105.09	105.88	
Soil	41.9	42.6	40.1	
Water Content				
σ_1	0	1.05	2.11	
σ_{III}	0.80	1.76	3.18	

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Proctor-Triaxial Data

Soil Sample QR 8U SG 06 TEST OM -4%

Modified Proctor Compaction

Optimum Moisture Content		21.0
To be compacted at		17.0
Allowance for evaporation		0.5
Total moisture to be added		17.5
Wt. of oven dried soil		4000
Volume of water added cc.		700
	(1)	(2)
No. of dish	114	125
Dish soil + water	243.83	245.83
Dish + soil	224.03	224.27
Dish	91.24	94.56
Water	19.80	21.56
Soil	132.79	129.71
Water Content dry wt.	14.9	16.6
Proctor cyl. + wet soil	3762	3395
Proctor cylinder	2153	1739
Wet soil	1609	1656
Dry soil	1400	1421
Equivalent Sp. Gr.	1.475	1.49
Dry Density	92.2	93.1

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	92.7	#/Cu.Ft.
Water content	15.7	%
ϕ	53.4°	
c	0.60	Tons/Sq.Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9443	9025	7908	
20	9350	9013	7900	
50	9231	8997	7889	
100	9067	8960	7874	
200	8815	8883	7845	
300	8568	8803	7816	
400	8361	8740	7788	
500	8177	8680	7760	
600	7988	8630	7737	
700	7775	8578	7716	
800		8532	7682	
900		8484	7658	
1000		8440	7635	
1100		8398	7607	
1200		8354	7581	
1300		8315	7557	
1400		8270	7533	
1500		8230	7508	
1600		8187	7479	
1700		8141	7452	
1800		8098	7426	
1900		8050	7400	
2000		8003	7375	
2100		7947	7348	
2200		7883	7320	
2300		7810	7285	
2400		7724	7255	
2500		7582	7225	
2600			7193	
2700			7153	
2800			7113	
2900			7065	
3000			7035	
3100			6967	
3200			6890	
3300			6830	
3400			6775	
Length	3.37"	3.40"	3.40"	
Dish No.	130	136	17A	
S, W + D	236.65	242.66	238.97	
Soil + Dish	216.05	223.20	218.39	
Wt. Dish	98.66	99.22	86.21	
Water	20.60	19.46	20.58	
Soil	117.39	123.98	132.18	
Water Content	17.5	15.7	15.6	
σ_1	0	1.05	2.11	
σ_{III}	3.43	13.32	18.79	

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Proctor-Triaxial Data

Soil Sample QR 8U SG 06 TEST CM - 2%

Modified Proctor Compaction		
Optimum Moisture Content		21.0
To be compacted at		19.0
Allowance for evaporation		0.5
Total moisture to be added		19.5
Wt. of oven dried soil		4000
Volume of water added cc.		780
	(1)	(2)
No. of dish	136	130
Dish soil + water	287.52	241.18
Dish + soil	258.42	303.04
Dish	99.22	98.66
Water	29.10	36.80
Soil	159.20	204.38
Water Content dry wt.	18.3	18.0
Proctor cyl. + wet soil	3432	3789
Proctor cylinder	1739	2153
Wet soil	1693	1636
Dry soil	1431	1388
Equivalent Sp. Gr.	1.500	1.470
Dry Density	94	92

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	93	#/Cu.Ft.
Water content	18.1	%
∅	49.0	°
c	0.78	Tons/Sq.Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test				
Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9129	9511	9655	
20	9110	9489	9644	
50	9084	9465	9630	
100	9034	9424	9598	
200	8882	9313	9497	
300	8716	9195	9382	
400	8589	9100	9270	
500	8490	9019	9163	
600	8377	8930	9050	
700	8252	8861	8953	
800	8147	8805	8866	
900		8733	8789	
1000	—	8672	8705	
1100		8606	8606	
1200		8550	8523	
1300		8485	8432	
1400		8410	8350	
1500		8341	8268	
1600		8254	8176	
1700		8162	8089	
1800		8058	8000	
1900		7942	7910	
2000		7785	7819	
2100		7525	7687	
2200			7565	
2300		—	7375	
2400			7040	
2500				
2600			—	
2700				
2800				
2900				
3000				
Length	3.59"	3.50"	3.27"	
Dish No.	M1	17A	114	
S, W + D	246.86	245.05	225.32	
Soil + Dish	222.32	219.28	204.87	
Wt. Dish	90.7	86.2	91.2	
Water	24.6	25.7	20.4	
Soil	131.6	133.1	113.7	
Water Content	18.7	19.3	17.9	
σ_1	0	1.05	2.11	
σ_{III}	4.00	11.21	13.37	

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Proctor-Triaxial Data

Soil Sample QR 8U SG 06 TEST OM ≠ 0%

Modified Proctor Compaction

Optimum Moisture Content		21.0
To be compacted at		21.5
Allowance for evaporation		1.0
Total moisture to be added		22.5
Wt. of oven dried soil		4000
Volume of water added cc.		900
	(1)	(2)
No. of dish	124	141
Dish soil ≠ water	297.61	270.80
Dish ≠ soil	262.16	240.22
Dish	94.15	101.41
Water	35.45	30.58
Soil	168.01	138.81
Water Content dry wt.	21.1	22.0
Proctor cyl. ≠ wet soil	3495	3389
Proctor cylinder	1739	2153
Wet soil	1756	1736
Dry soil	1450	1421
Equivalent Sp. Gr.	1.530	1.497
Dry Density	95.0	93.6

Machine Number	1	
Pressure Medium	Air	
Wt. of piston ≠ head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	94.4	#/Cu.Ft.
Water content	21.5	%
ø	46.7	°
c	1.12	Tons/Sq.Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9725	9761	9009	
20	9717	9745	8998	
50	9698	9685	8970	
100	9659	9661	8730	
200	9577	9601	8515	
300	9504	9533	8280	
400	9450	9464	8062	
500	9397	9397	7162	
600	9346	9325	7659	
700	9298	9262	7481	
800	9248	9187	7321	
900	9190	9117	7180	
1000	9132	9050	7058	
1100	9052	8971	6916	
1200	8940	8889	6778	
1300	———	8800	6660	
1400		8713	6542	
1500		8632	6427	
1600		8523	6290	
1700		8421	6151	
1800		8310	5995	
1900		8180	4856	
2000		8030	4658	
2100		7845	4471	
2200		7600	4212	
2300		7159	3941	
2400		———	3490	
2500			———	
2600				
2700				
2800				
2900				
3000				
Length	3.52"	3.44"	3.50"	
Dish No.	136	130	M17	
S, W ≠ D	255.22	254.00	247.86	
Soil ≠ Dish	228.46	226.27	218.61	
Wt. Dish	99.22	98.66	89.72	
Water	26.76	27.73	29.25	
Soil	129.24	127.61	128.89	
Water Content	20.7	21.7	22.7	
σ_1	0	1.05	2.11	
σ_{III}	5.54	11.95	13.37	

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Proctor-Triaxial Data

Soil Sample CR 8U SG 06 TEST CM ∠ 2%

Modified Proctor Compaction

Optimum Moisture Content		21.0
To be compacted at		23.0
Allowance for evaporation		1.0
Total moisture to be added		24.0
Wt. of oven dried soil		4000
Volume of water added cc.		960
	(1)	(2)
No. of dish	68A	
Dish soil ∠ water	252.2	
Dish ∠ soil	219.3	
Dish	83.0	
Water	32.9	
Soil	136.3	
Water Content dry wt.	24.1	
Proctor cyl. ∠ wet soil	3833	3498
Proctor cylinder	2132	1739
Wet soil	1701	1759
Dry soil	1369	1418
Equivalent Sp. Gr.	1.450	1.468
Dry Density	90.6	91.6

Machine Number	1	
Pressure Medium	Air	
Wt. of piston ∠ head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	91.0	#/Cu.Ft.
Water content	24.1	%
∅	40.0	°
c	1.21	Tons/Sq.Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4
Applied Load gms	Dial Readings			
0	9985	9710	9515	
20	9950	9700	9495	
50	9930	9685	9470	
100	9880	9630	9415	
200	9750	9415	9310	
300	9610	9180	9205	
400	9440	8925	9100	
500	9295	8685	9000	
600	9115	8470	8830	
700	8935	8240	8660	
800	8745	8025	8590	
900	8555	7810	8480	
1000	8265	7565	8365	
1100	———	7390	8230	
1200		7190	8120	
1300		6985	8010	
1400		6750	7860	
1500		6505	7700	
1600		6070	7460	
1700		5790	7260	
1800		5560	7015	
1900		5000	6775	
2000		———	6540	
2100			6130	
2200			5100	
2300			———	
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.70"	3.95	3.90	
Dish No.	M19	68A	23	
S, W ∠ D	253.51	252.22	256.47	
Soil ∠ Dish	220.29	219.30	223.90	
Wt. Dish	88.7	83.0	84.6	
Water	33.2	32.9	32.6	
Soil	131.6	136.3	139.3	
Water Content	25.2	24.1	23.4	
σ_1	0	1.05	2.11	
σ_{III}	4.91	9.62	12.11	

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Proctor-Triaxial Data

Soil Sample QR 8U SG 06 TEST OM + 4 %

Modified Proctor Compaction		
Optimum Moisture Content		21.0
To be compacted at		26.0
Allowance for evaporation		1.0
Total moisture to be added		27.0
Wt. of oven dried soil		4000
Volume of water added cc.		1080
	(1)	(2)
No. of dish	17 A	125
Dish soil + water	319.42	302.5
Dish + soil	268.55	256.67
Dish	86.2	94.56
Water	50.87	45.83
Soil	182.3	162.11
Water Content dry wt.	27.9	28.3
Proctor cyl. + wet soil	3564	3930
Proctor cylinder	1739	2153
Wet soil	1825	1777
Dry soil	1429	1387
Equivalent Sp. Gr.	1.480	1.460
Dry Density	92.5	91.3

Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	91.9	#/Cu. Ft.
Water content	28.1	%
∅	8.3^0	
c	2.57	Tons/Sq. Ft.

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1 0	2 15	3 30	4 45
Applied Load gms	Dial Readings			
0	9523	9895	9310	9964
20	9517	9880	9301	9960
50	9488	9848	9272	9955
100	9430	9788	9227	9930
200	9300	9661	9100	9828
300	9179	9486	8892	9563
400	9039	9307	8688	9238
500	8879	9120	8490	8925
600	8703	8930	8285	8580
700	8519	8740	8110	8229
800	8295	8540	7900	7870
900	8052	8325	7690	7532
1000	7797	8092	7458	7200
1100	7440	7772	7207	6838
1200	6920	7430	6915	6456
1300		6885	6508	5850
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.70"	3.73"	3.91"	3.88"
Dish No.	53A	136	M-17	M 1
S, W + D	274.40	278.17	276.72	257.93
Soil + Dish	238.67	240.18	237.28	223.62
Wt. Dish	100.86	99.22	89.72	90.7
Water	35.73	37.99	39.44	34.3
Soil	137.81	140.96	147.56	132.9
Water Content	25.9	27.0	26.7	25.8
σ_1	0	1.05	2.11	3.16
σ_{III}	5.74	7.18	8.31	9.14

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Proctor-Triaxial Data

Soil Sample QR 8U SG 06 TEST 90% Max. Density

Modified Proctor Compaction

Optimum Moisture Content		
To be compacted at		31.5
Allowance for evaporation		0
Total moisture to be added		31.5
Wt. of oven dried soil		4000
Volume of water added cc.		1260
	(1)	(2)
No. of dish	17 A	
Dish soil + water	200.35	280.30
Dish + soil	171.88	235.30
Dish	86.80	97.69
Water	28.47	45.00
Soil	85.68	137.61
Water Content dry wt.	33.2	32.7
Proctor cyl. + wet soil	3806	3467
Proctor cylinder	2150	1742
Wet soil	1656	1725
Dry soil	1248	1299
Equivalent Sp. Gr.	1.318	1.345
Dry Density	82.5	84.0

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80 Cm^2
Dry density	83.2 #/Cu.Ft.
Water content	33.0 %
ø	6.8 °
c	1.0 Tons/Sq.Ft.

Note: Loads applied on one quarter minute each quarter-and-half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9720	8429	8748	
20 10	9675	8410	8743	
50 20	9658	8369	8731	
100 50	9589	8284	8693	
200 100	9386	7980	8602	
300 150	9215	7655	8444	
400 200	8992	7385	8215	
500 250	8825	7052	7918	
600 300	8598	6700	7565	
700 350	8320	6400	7180	
800 400	7960	6030	6735	
900 450	7330	5480	5060	
1000 500		4900	4360	
1100 550		3930		
1200 600				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length				
Dish No.	5.85"	5.69"	5.55"	
S, W + D	114	142	111	
Soil + Dish	263.34	259.31	247.80	
Wt. Dish	223.30	222.92	211.21	
Water	91.2	101.6	90.7	
Soil	40.0	36.4	36.6	
Water Content	132.1	121.3	120.5	
	30.3	30.1	30.5	
σ_1	0	1.85	2.11	
σ_{III}	2.19	3.55	4.38	

University of Alberta
Proctor-Triaxial Data

Soil Sample QR SU SG 06 TEST 85% Max. Density

Modified Proctor Compaction

Optimum Moisture Content	
To be compacted at	35.0
Allowance for evaporation	0.5
Total moisture to be added	35.5
Wt. of oven dried soil	4000
Volume of water added cc.	1400

	(1)	(2)
No. of dish	109	M 17
Dish soil + water	297.79	273.39
Dish + soil	240.72	222.73
Dish	89.33	89.72
Water	57.07	50.66
Soil	151.39	133.01
Water Content dry wt.	37.7	38.1
Proctor cyl. + wet soil	3425	3790
Proctor cylinder	1742	2153
Wet soil	1683	1637
Dry soil	1222	1185
Equivalent Sp. Gr.	1.280	1.248
Dry Density	80.0	78.1

Machine Number 1
Pressure Medium Air
Wt. of piston + head 0.408 Kg.
Area of Samples 9.80 Cm^2

Dry density 79.0 #/Cu.Ft.
Water content 37.9%
ϕ 2.20°
c 0.63 Tons/Sq.Ft.

Note: Loads applied on ~~minute and half minute~~ each quarter

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
Applied Load gms	0	15	30	
	Dial Readings			
~~0~~ ~~10~~	9720	9370	9329	
~~20~~ 10	9697	9361	9317	
~~50~~ 20	9645	9343	9297	
~~100~~ 50	9497	9275	9241	
~~200~~ 100	9200	8868	9110	
~~300~~ 150	8630	8420	8880	
~~400~~ 200	7660	7655	8405	
~~500~~ 250	5880	6230	7560	
~~600~~ 300	2930	4530	5980	
~~700~~ 350	———	1730	3710	
~~800~~ 400		———	0090	
900			———	
1000				
1100				
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1300				
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2400				
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2600				
2700				
2800				
2900				
3000				
Length	3.57"	3.28"	3.11"	
Dish No.	137	133	49	
S, W + D	203.15	200.16	189.60	
Soil + Dish	160.28	160.00	150.64	
Wt. Dish	48.60	54.41	46.70	
Water	42.87	40.16	38.96	
Soil	111.68	105.59	103.94	
Water Content	36.6	38.1	37.5	
σ_1	0	1.05	2.11	
σ_{III}	1.28	2.44	3.57	

University of Alberta

Proctor-Triaxial Data

Soil Sample QR 8U SG 06 TEST 80% Max. Density

Modified Proctor Compaction

Optimum Moisture Content	
To be compacted at	39.6
Allowance for evaporation	0.5
Total moisture to be added	39.5
Wt. of oven dried soil	4000
Volume of water added cc.	1580

	(1)	(2)
No. of dish	137½	122(½)
Dish soil + water	180.73	223.30
Dish + soil	140.75	172.56
Dish	48.60	55.22
Water	39.98	50.74
Soil	92.15	117.34
Water Content dry wt.	43.5	43.3
Proctor cyl. + wet soil	3736	3394
Proctor cylinder	2153	1742
Wet soil	1583	1652
Dry soil	1103	1151
Equivalent Sp. Gr.	1.162	1.206
Dry Density	72.6	75.2

Machine Number	1
Pressure Medium	Air
Wt. of piston + head	0.407 Kg.
Area of Samples	9.80, Cm^2
Dry density	73.9 #/Cu.Ft.
Water content	43.4 %
Ø	4.4°
c	0.46 tons/sq.ft.

each quarter

Note: Loads applied on minute and half minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial Readings			
0	9833	9128	9120	
10	9790	9093	9096	
20	9733	9050	9065	
50	9355	8825	8970	
100	8270	7910	8395	
200	4100	6630	7260	
300		4220	4400	
400				
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2700				
2800				
2900				
3000				

Length		3.80"	3.58"	3.82"
Dish No.	54A(½)	207.12	119(½)	49 (½)
S, W + D		200.30		214.20
Soil + Dish		158.11		164.49
Wt. Dish		45.22		46.70
Water		49.01		49.71
Soil		112.89		117.79
Water Content		43.5		42.3
σ_1		0	1.05	2.11
σ_{III}		.685	1.98	3.04

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Proctor-Triaxial Data

Soil Sample QR 8U SC 06 TEST 75% Max. Density

Modified Proctor Compaction

Optimum Moisture Content	21.5
To be compacted at	44.5
Allowance for evaporation	1.5
Total moisture to be added	46.0
Wt. of oven dried soil	4000
Volume of water added cc.	1840

	(1)	(2)
No. of dish	109	M6
Dish soil + water	269.68	253.30
Dish + soil	209.10	199.50
Dish	82.40	87.82
Water	60.58	53.72
Soil	119.70	111.76
Water Content dry wt.	50.6	48.2
Proctor cyl. + wet soil	3673	3589
Proctor cylinder	2132	1742
Wet soil	1541	1590
Dry soil	1025	1072
Equivalent Sp. Gr.	1.085	1.112
Dry Density	67.8	69.5

Machine Number 1
Pressure Medium Air
Wt. of piston + head 0.408 Kg.
Area of Samples 9.80 Cm^2

Dry density 68.6 #/Cu.Ft.
Water content 49.4 %
ϕ 0.6°
c 0.22 Tons/Sq.Ft.

Note: Loads applied on ~~minute and half~~ each quarter minute

Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	
Applied Load gms	Dial. Readings			
0	9470	9496	1.0042	
20 10	9392	9171	9400	
50 30	9246	9075	9180	
100 50	7840	8195	8530	
200 100	2000	4000	5210	
300 150				
400 200				
500 250				
600 300				
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
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2600				
2700				
2800				
2900				
3000				
Length	5.30"	5.25"	5.25"	
Dish No.	M 7	55	154	
S, W + D	232.63	227.52	241.36	
Soil + Dish	186.62	182.04	194.04	
Wt. Dish	95.19	92.22	97.23	
Water	45.81	45.22	47.32	
Soil	91.53	89.22	96.81	
Water Content	50.0	50.8	48.9	
σ_1	0	1.05	2.11	
σ_{III}	.43	1.51	2.54	

University of Alberta

Proctor-Triaxial Data

Soil Sample QR SU SG 06 · TEST 80% Max. Density

Modified Proctor Compaction

Optimum Moisture Content		21.5
To be compacted at		37.5
Allowance for evaporation		1.5
Total moisture to be added		39.0
Wt. of oven dried soil		4000
Volume of water added cc.		1560
	(1)	(2)
No. of dish	55	m6
Dish soil + water	246.26	220.35
Dish + soil	200.84	179.62
Dish	92.22	87.80
Water	45.42	40.73
Soil	108.02	91.82
Water Content dry wt.	42.0	44.1
Proctor cyl. + wet soil	5752	5566
Proctor cylinder	2132	1742
Wet soil	1606	1624
Dry soil	1132	1128
Equivalent Sp. Gr.	1.199	1.175
Dry Density	74.8	73.5

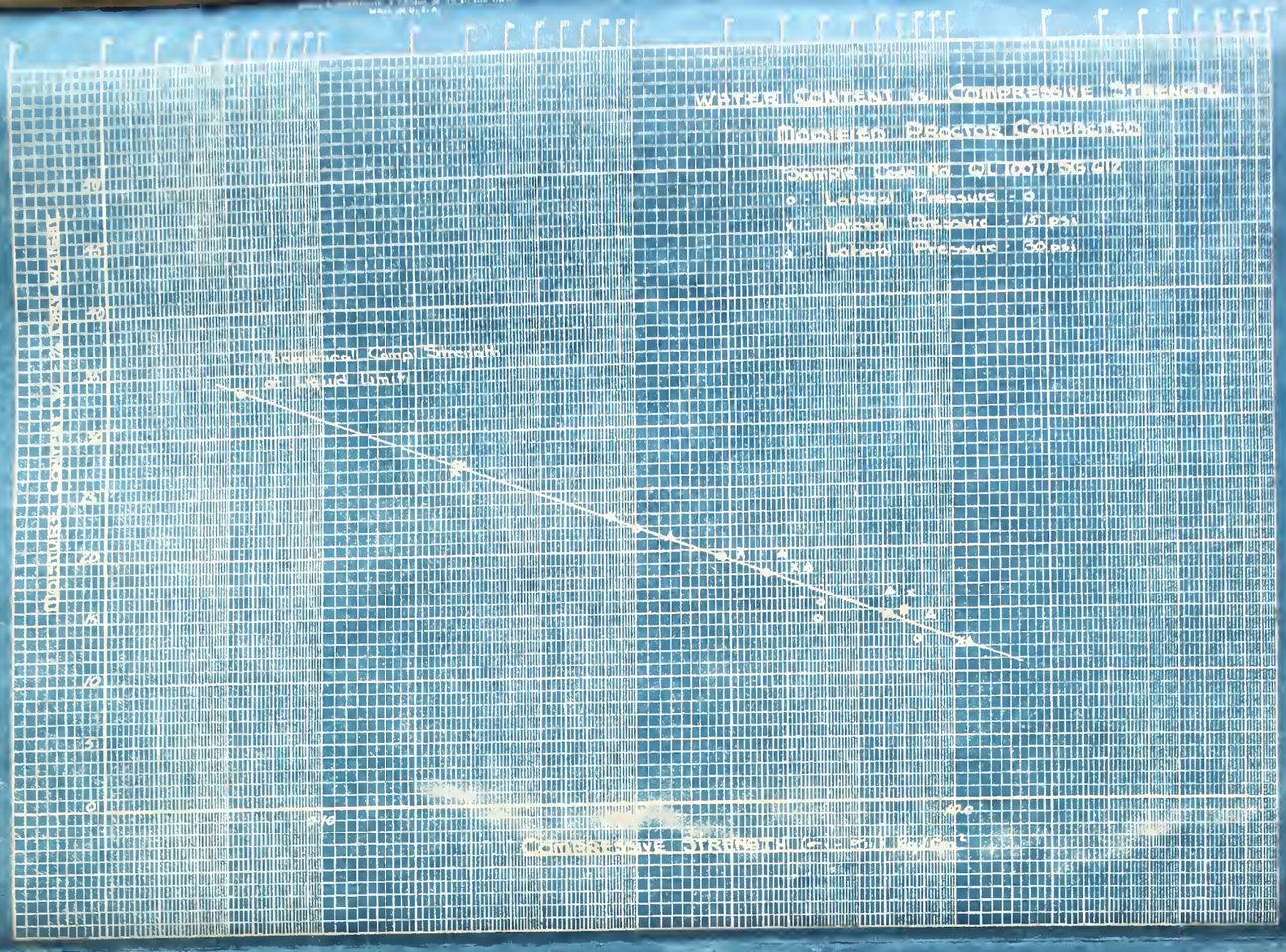
Machine Number	1	
Pressure Medium	Air	
Wt. of piston + head	0.407	Kg.
Area of Samples	9.80	Cm^2
Dry density	74.1	#/Cu.Ft.
Water content	43.0	%
ø	5.5°	
c	0.32	Tons/Sq.Ft.

Note: Loads applied on each quarter minute and half minute

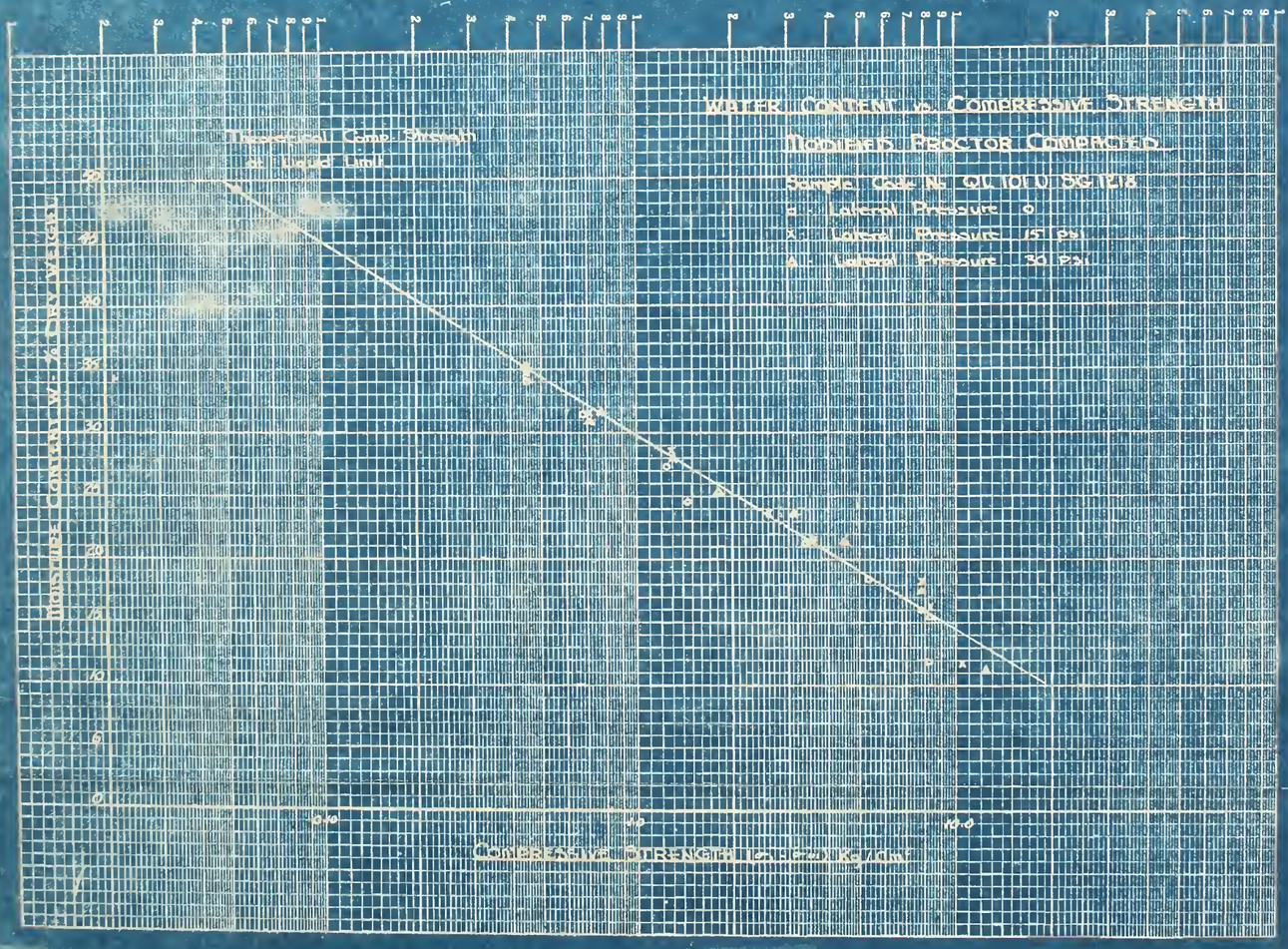
Triaxial Compression Test

Pressure p.s.i.	1	2	3	4
	0	15	30	30
Applied Load gms	Dial Readings			
0	9737	9531	9301	9501
~~20~~ 10	9696	9324	9284	9490
~~50~~ 20	9640	9287	9251	9477
~~100~~ 50	9332	9195	9169	9425
~~200~~ 100	8240	8730	8732	9270
~~300~~ 150	5610	7750	7600	8630
~~400~~ 200		6700		7130
~~500~~ 250		4200		4800
~~600~~ 300				0050
~~700~~ 350				
~~800~~ 400				
~~900~~ 450				
~~1000~~ 500				
1100				
1200				
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
Length	3.55"	3.51"	3.61"	3.60"
Dish No.	M 7	136	17A	109
S, W + D	243.15	252.43	241.92	244.24
Soil + Dish	702.83	206.72	194.92	198.12
Wt. Dish	95.19	99.22	86.15	89.33
Water	45.32	45.71	47.00	46.12
Soil	107.64	107.50	107.77	108.79
Water Content	42.0	42.6	43.6	42.3
σ_1	0	1.05		2.11
σ_{III}	0.94	2.10		3.45

KEUFFEL & ESSER CO., N. Y. NO. 359-61
Semi-Logarithmic, 4 Cycles × 10 to the Inch.
MADE IN U. S. A.


Water Content vs. Compressive Strength
Modified Proctor Compacted
Theoretical Comp. Strength at Liquid Limit
Compressive Strength (Lbs/Sq. In.)
Water Content (% of Dry Weight)

KEUFFEL & ESSER CO., N. Y. NO. 359-61
Semi-Logarithmic, 4 Cycles × 10 to the Inch.
MADE IN U. S. A.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Theoretical Comp. Strength at Liquid Limit
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Water Content (% of Dry Weight)

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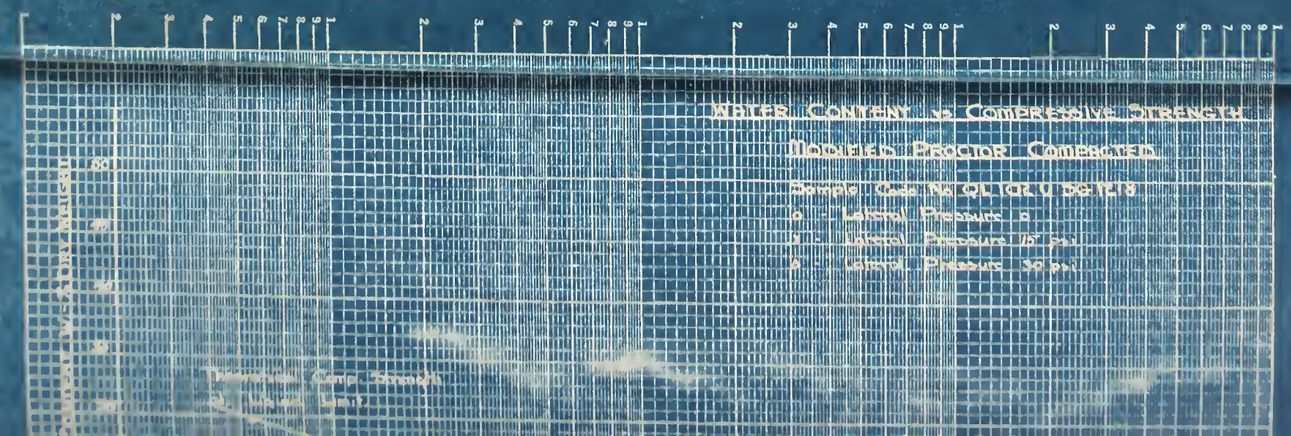
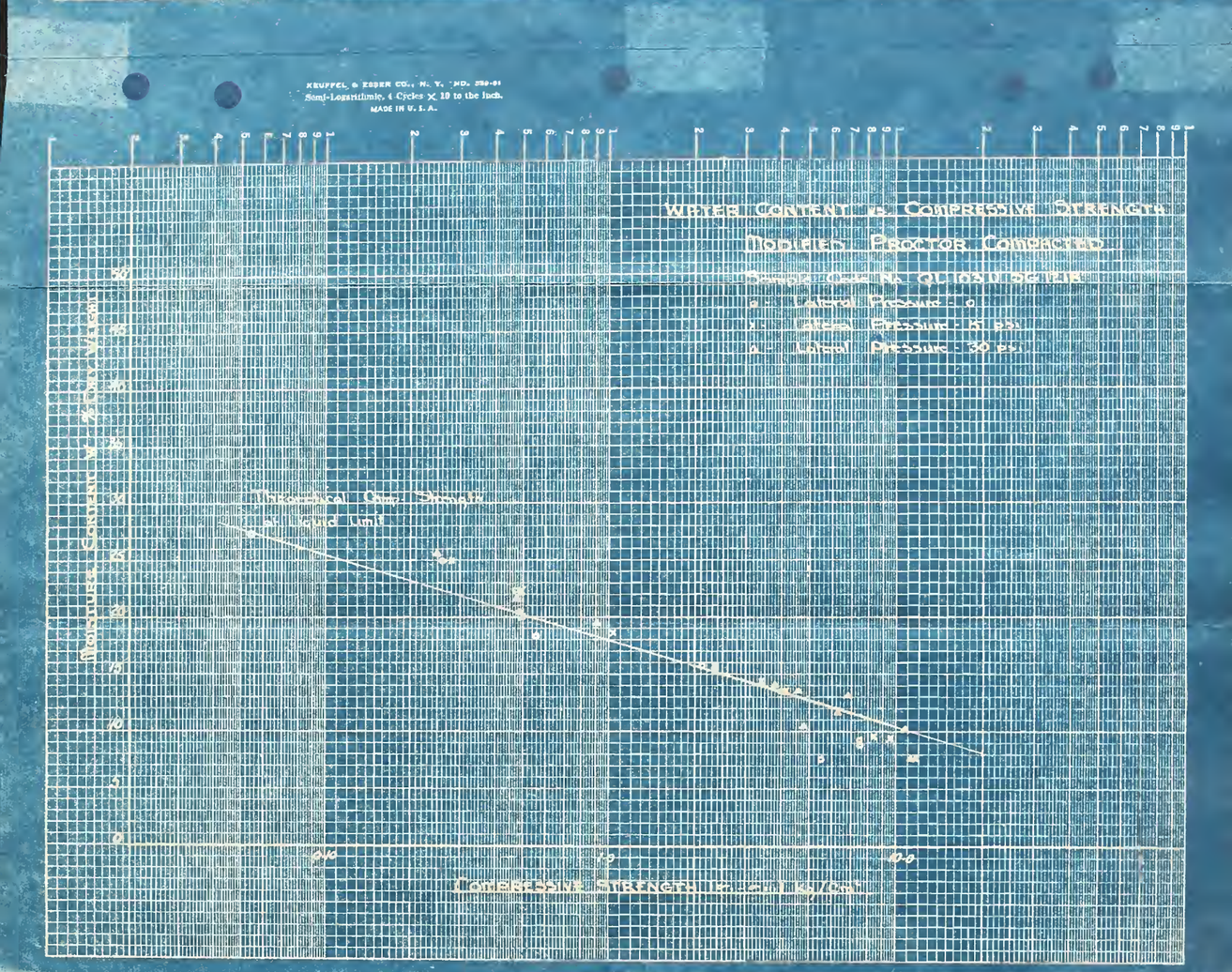
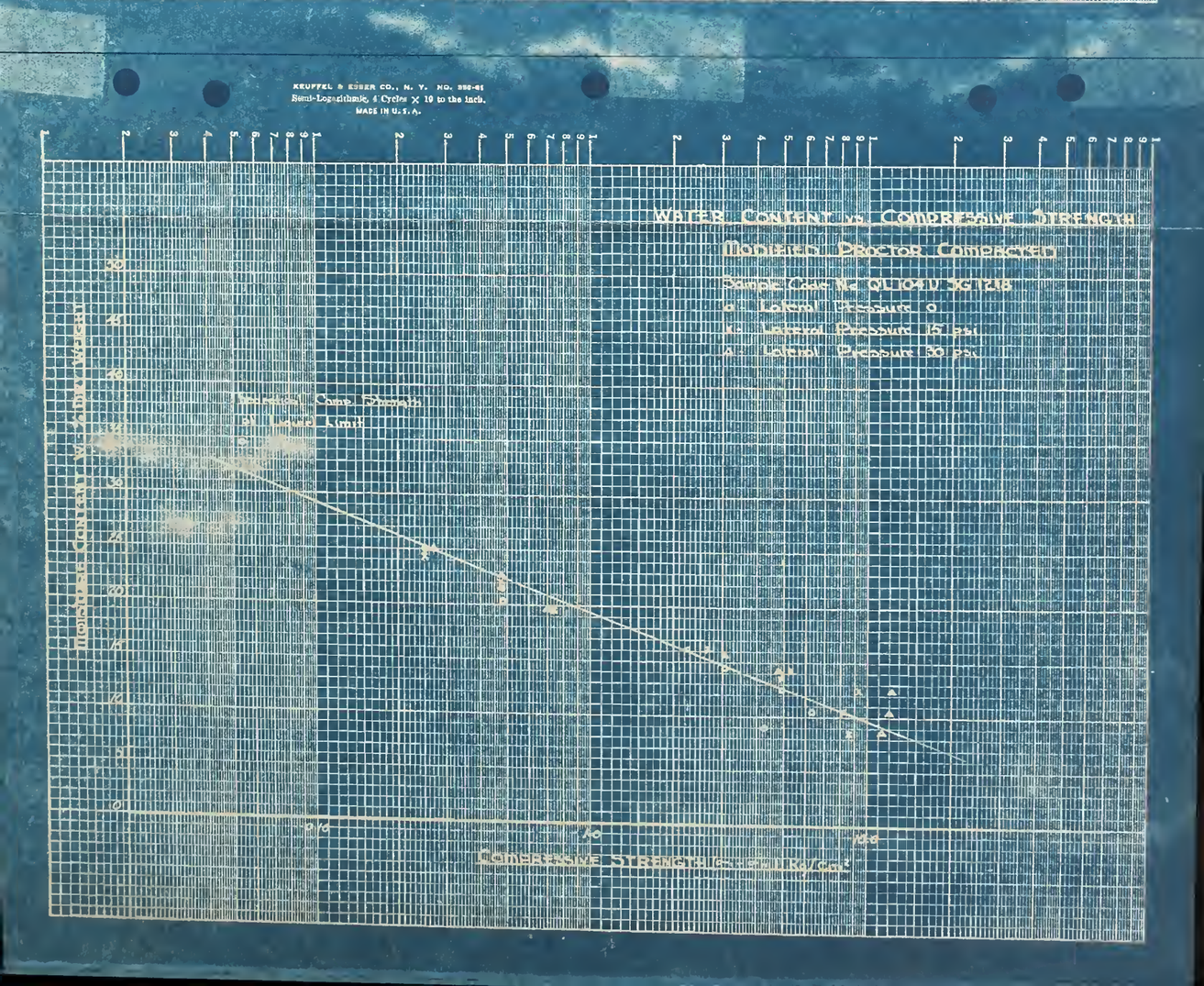

Water Content vs. Compressive Strength
Modified Proctor Compacted
Theoretical Comp. Strength at Liquid Limit
Compressive Strength (Lbs/Sq. In.)
Water Content (% of Dry Weight)

KRUFFEL & ESSER CO., N. Y. NO. 359-61
Semi-Logarithmic, 4 Cycles X 10 to the inch.
MADE IN U. S. A.


Water Content vs. Compressive Strength
Modified Proctor Compacted
Sample Case No. QU 1651 thru 54 (#18
A - Lateral Pressure 0
B - Lateral Pressure 15 psi
C - Lateral Pressure 30 psi
Theoretical Case Strength
at Liquid Limit
Compressive Strength in lbs/sq.in.

KRUFFEL & ESSER CO., N. Y. NO. 359-61
Semi-Logarithmic, 4 Cycles X 10 to the inch.
MADE IN U. S. A.


Water Content vs. Compressive Strength
Modified Proctor Compacted
Sample Case No. QU 1040 thru 43 (#18
A - Lateral Pressure 0
B - Lateral Pressure 15 psi
C - Lateral Pressure 30 psi
Theoretical Case Strength
at Liquid Limit
Compressive Strength in lbs/sq.in.

MOISTURE - DRY DENSITY CURVE

Modified Proctor Test

Sample Code No. QL10U5G612

Optimum Moisture Content 12.8%

Maximum Dry Density 1.324 gm/cm³

Core Borers, Values ¾" ø

Note: Average Moist. Cond. to Dry Density

Liquid Limit

Plastic Limit

Natural Moisture Content

Natural Dry Density

Degree of Saturation

Void Ratio

Specific Gravity

Dry Density gm/cm³

Moisture Content %

HUGHES OWENS 315C 10x10

TRIAXIAL COMPRESSION TEST

Sample Code No. QL10U5G612

Moisture Content 12.6 %

UNIT STRESS kg/cm²

STRAIN %

SHEARING STRESS kg/cm²

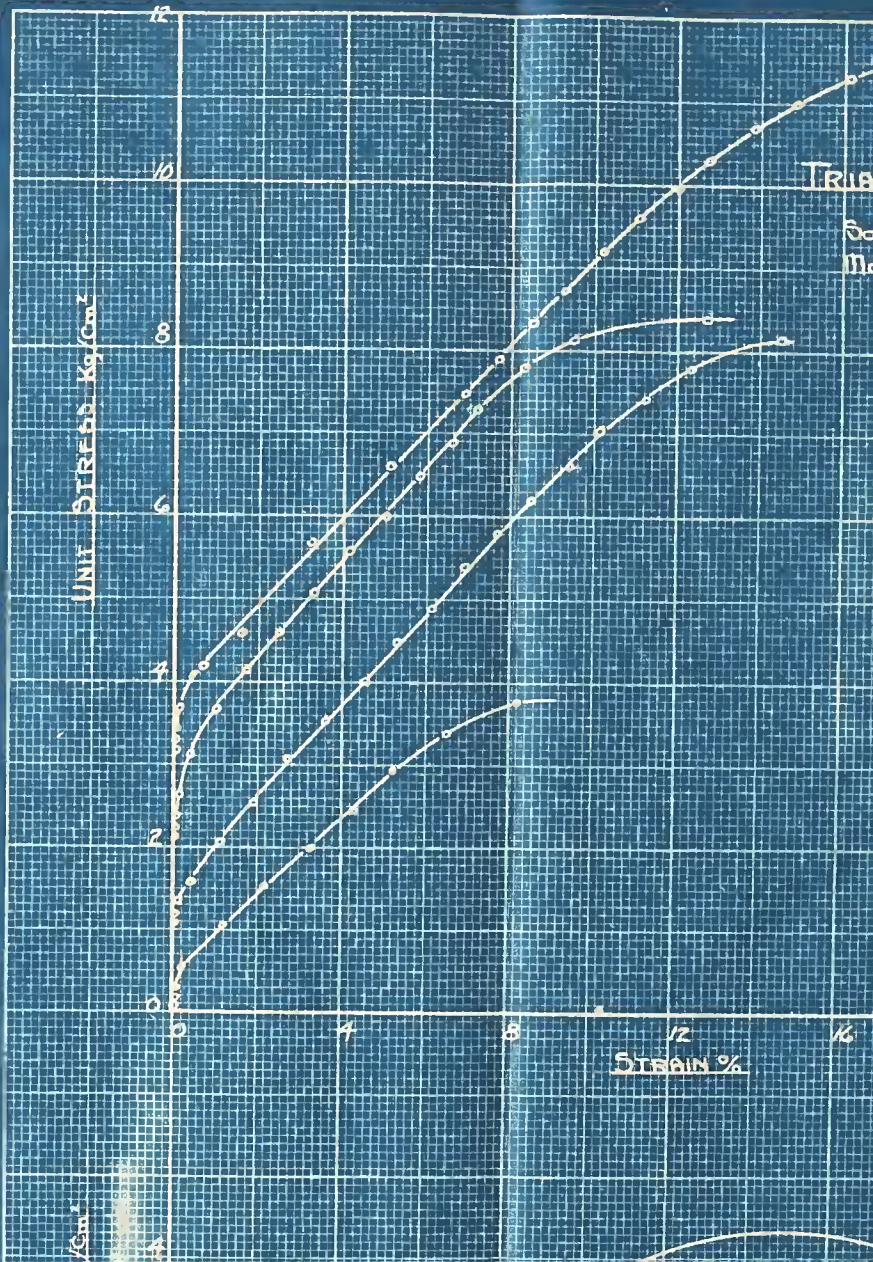
NORMAL STRESS kg/cm²

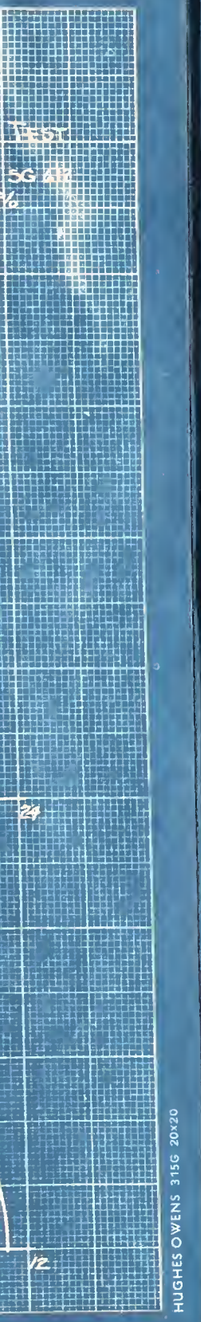
HUGHES OWENS 315G 20x20

XIAL COMPRESSION TEST

mple Code No QL 1024 5G612

isture Content 12.6 %

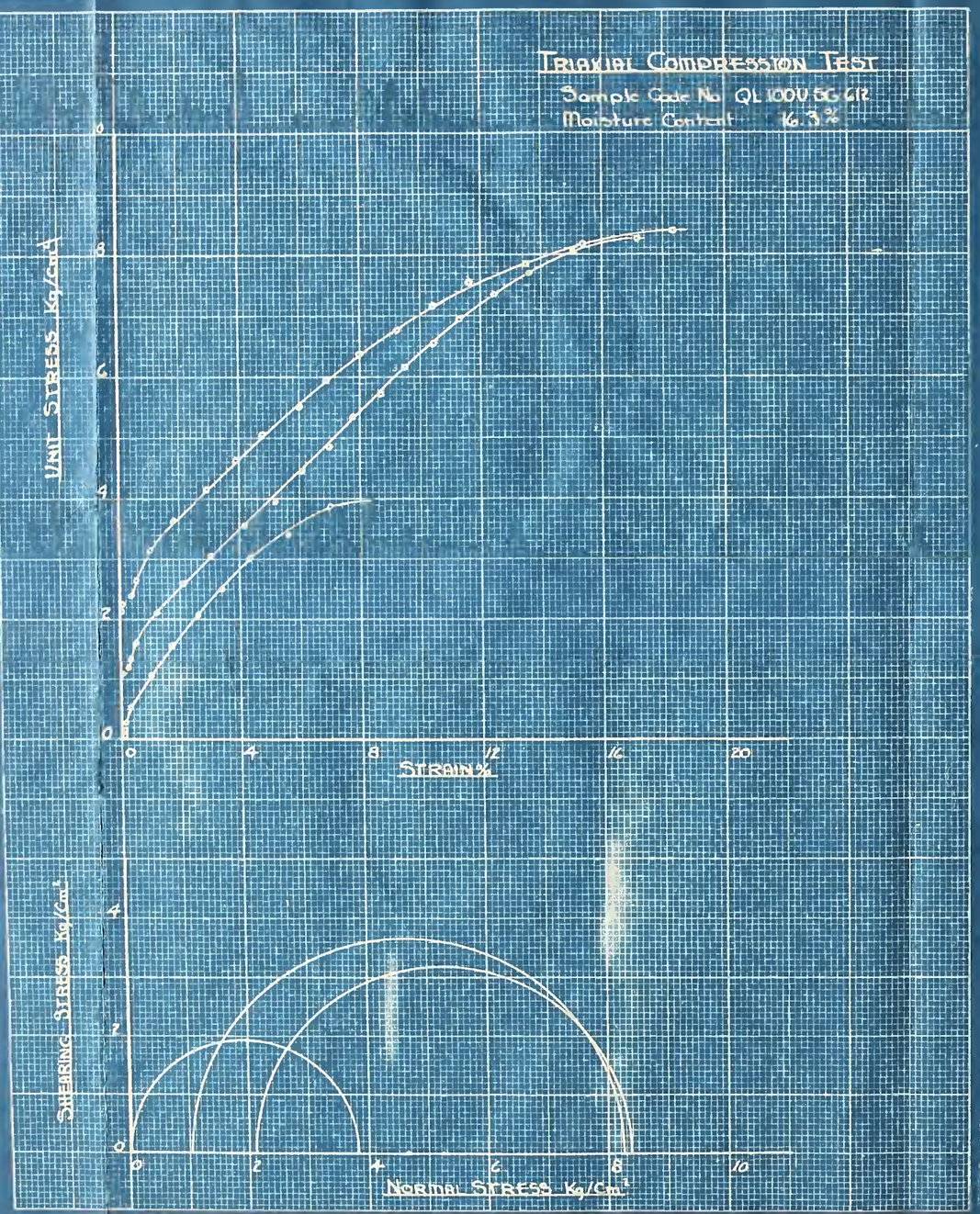




HUGHES OWENS 315G 20×20

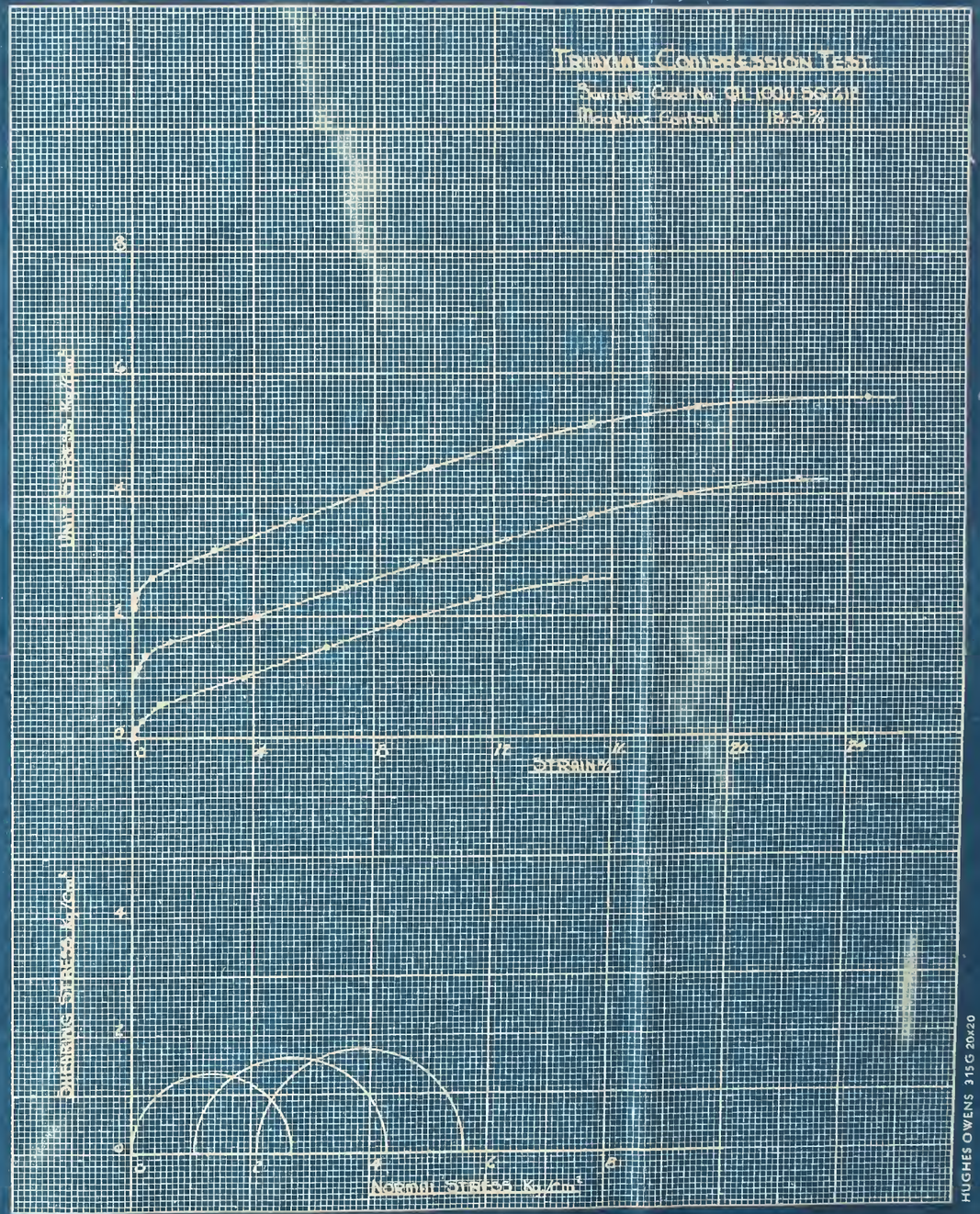
Triaxial Compression Test

Sample Code No QL 1000 SC 412
Moisture Content 16.3 %



HUGHES OWENS 315G 20×20

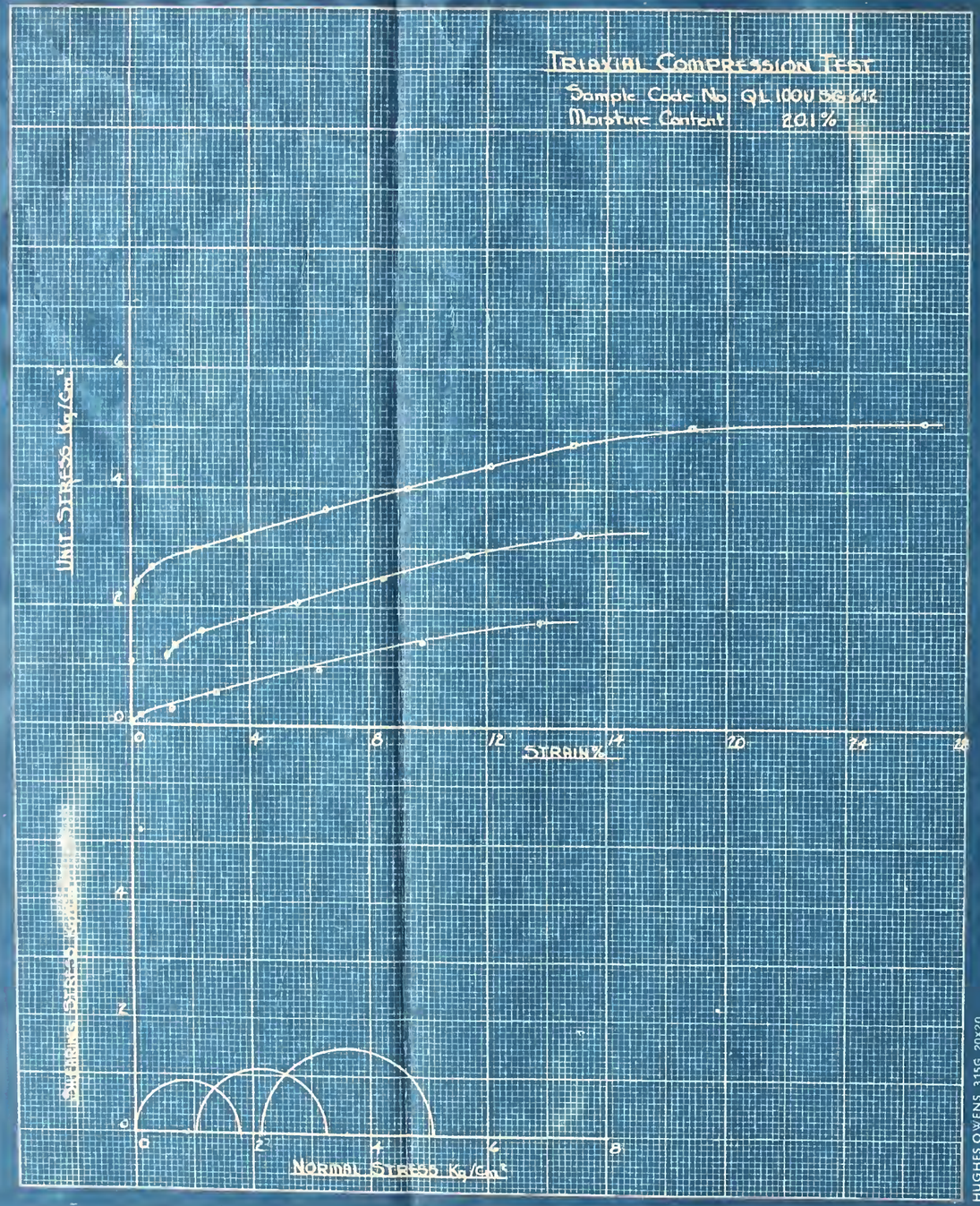
Triaxial Compression Test
Sample Code No QL 1000 SC 412
Moisture Content 16.3 %



HUGHES OWENS 315G 20×20

Triaxial Compression Test

Sample Code No. QL100 SG 612
Moisture Content 20.1%



HUGHES OWENS 315G 20x20

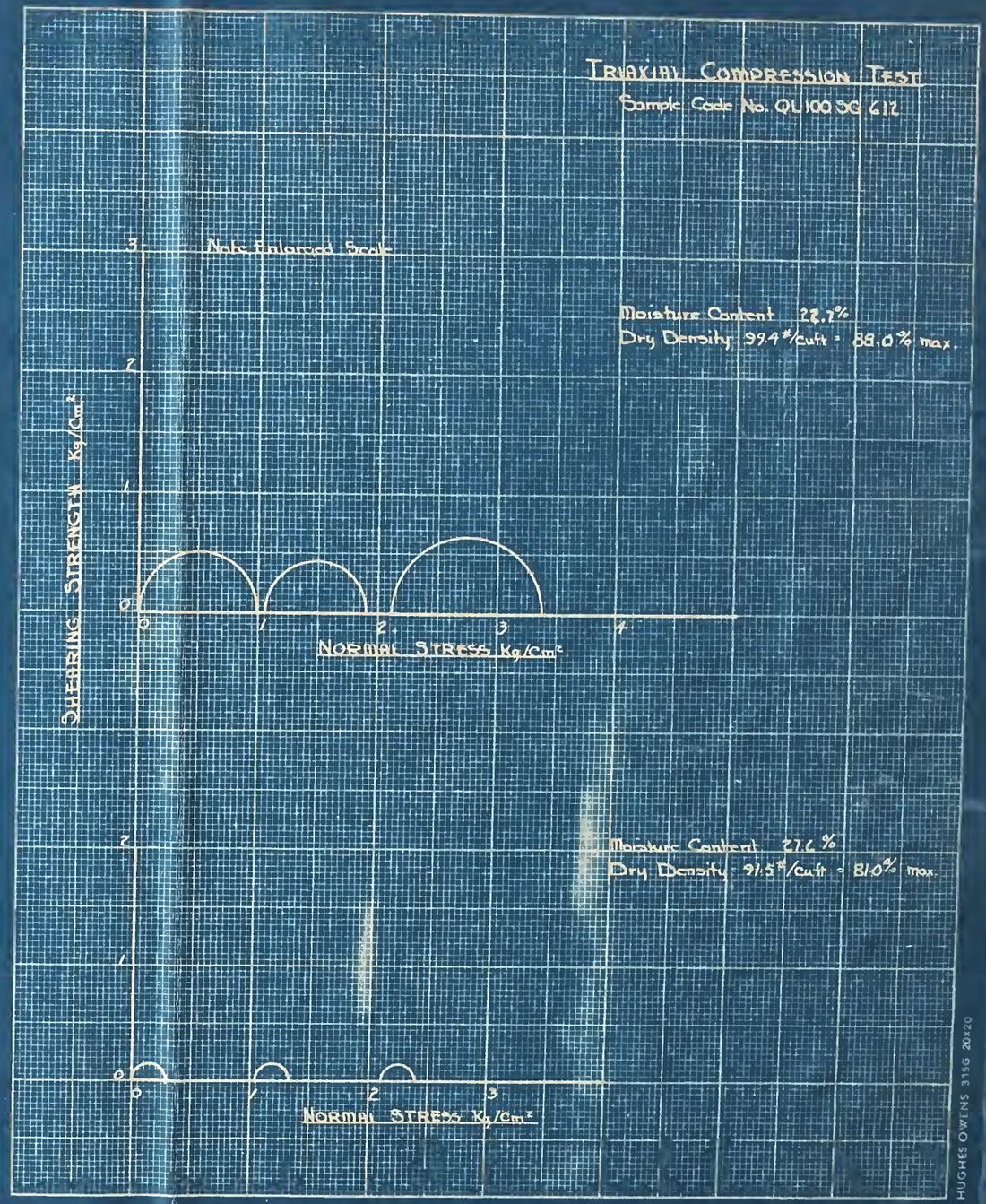
Triaxial Compression Test

Sample Code No. QL100 SG 612

Note: Enlarged Scale

Moisture Content 22.7%
Dry Density: 99.4 #/cuft = 88.0% max.

Moisture Content 27.6%
Dry Density: 91.5 #/cuft = 81.0% max.



HUGHES OWENS 315G 20x20

Moisture - Dry Density Curve

Sample Code No. QL 1011 SS 1218
Optimum Moisture Content 12.2%
Maximum Dry Density 1018 gm/cm³

Core Cutting Test

Core Cutting Test

Note: 6" = Laboratory Mould Dry Density

Moisture Content % Dry Wt.

Dry Density lbs per cu ft at Natural Moisture

Airport Extension
Runway NE-SW
Station 2+74
Offset 12' Lt

HUGHES OWENS 315C 10×10

Triaxial Compression Test

Sample Code No. QL 1011 SS 1218
Moisture Content 12.3%

Note Reduced Scale

Unit Stress Kg/cm²

Strain %

Shearing Stress Kg/cm²

Normal Stress Kg/cm²

HUGHES OWENS 315G 20×20

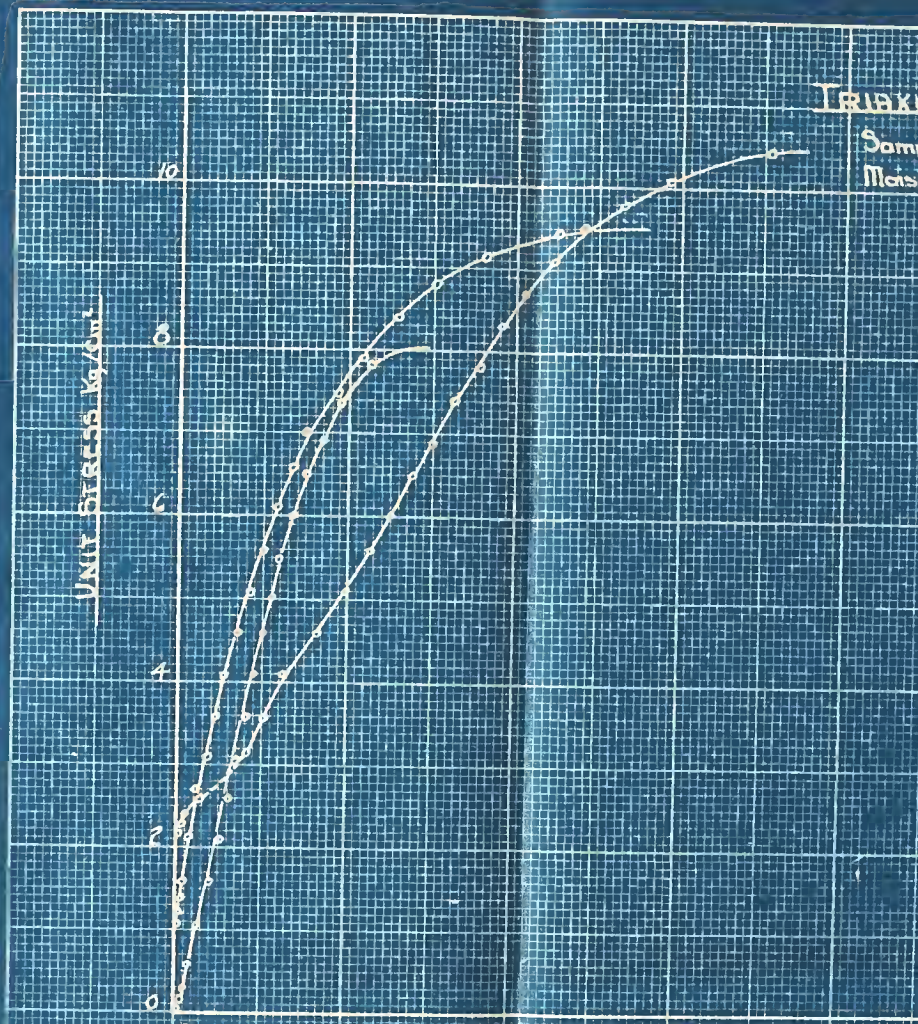
Unit Stress Kg/cm²

Shearing Stress Kg/cm²

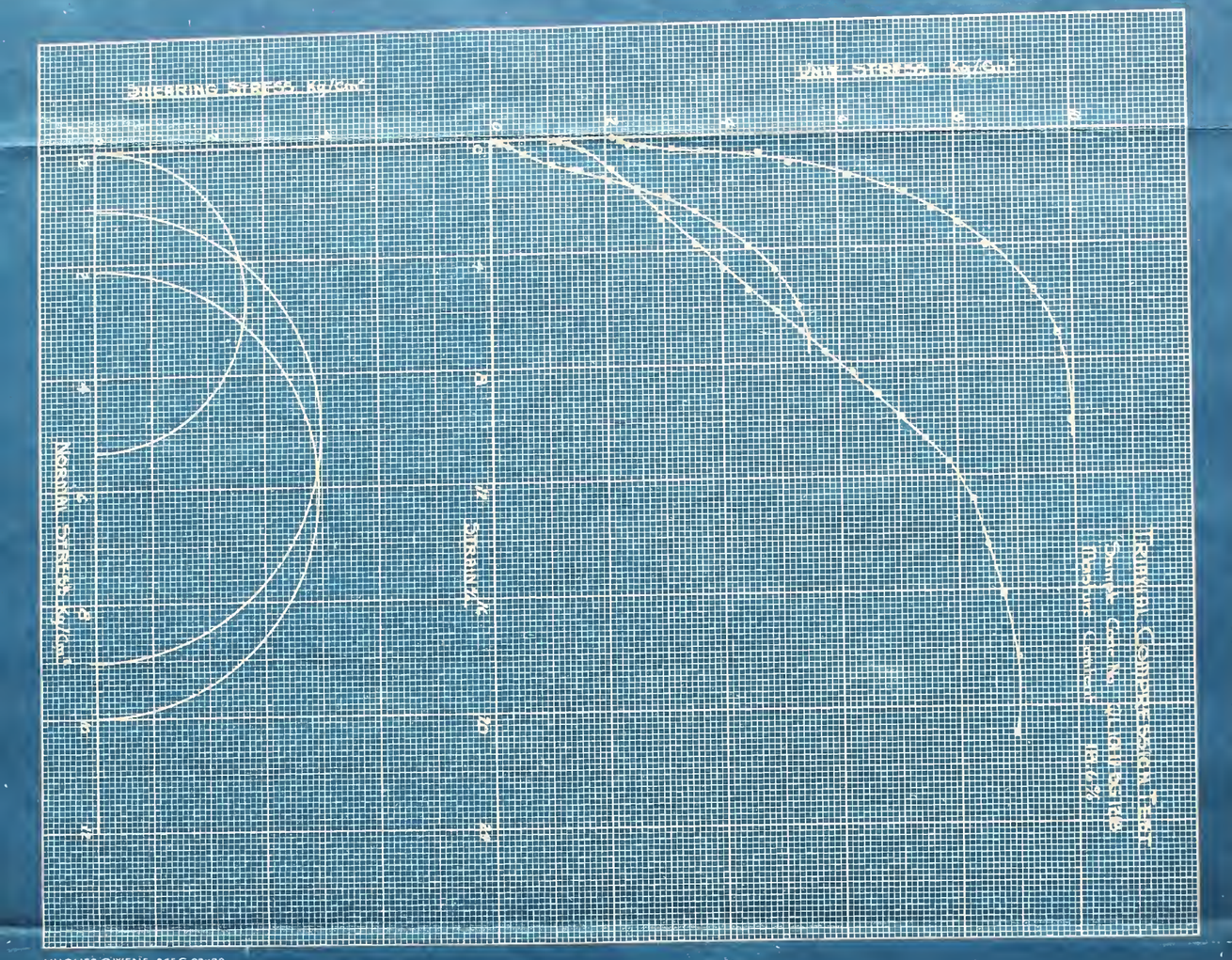
AXIAL COMPRESSION TEST

Sample Code No. QL 1014 U 5G 1218

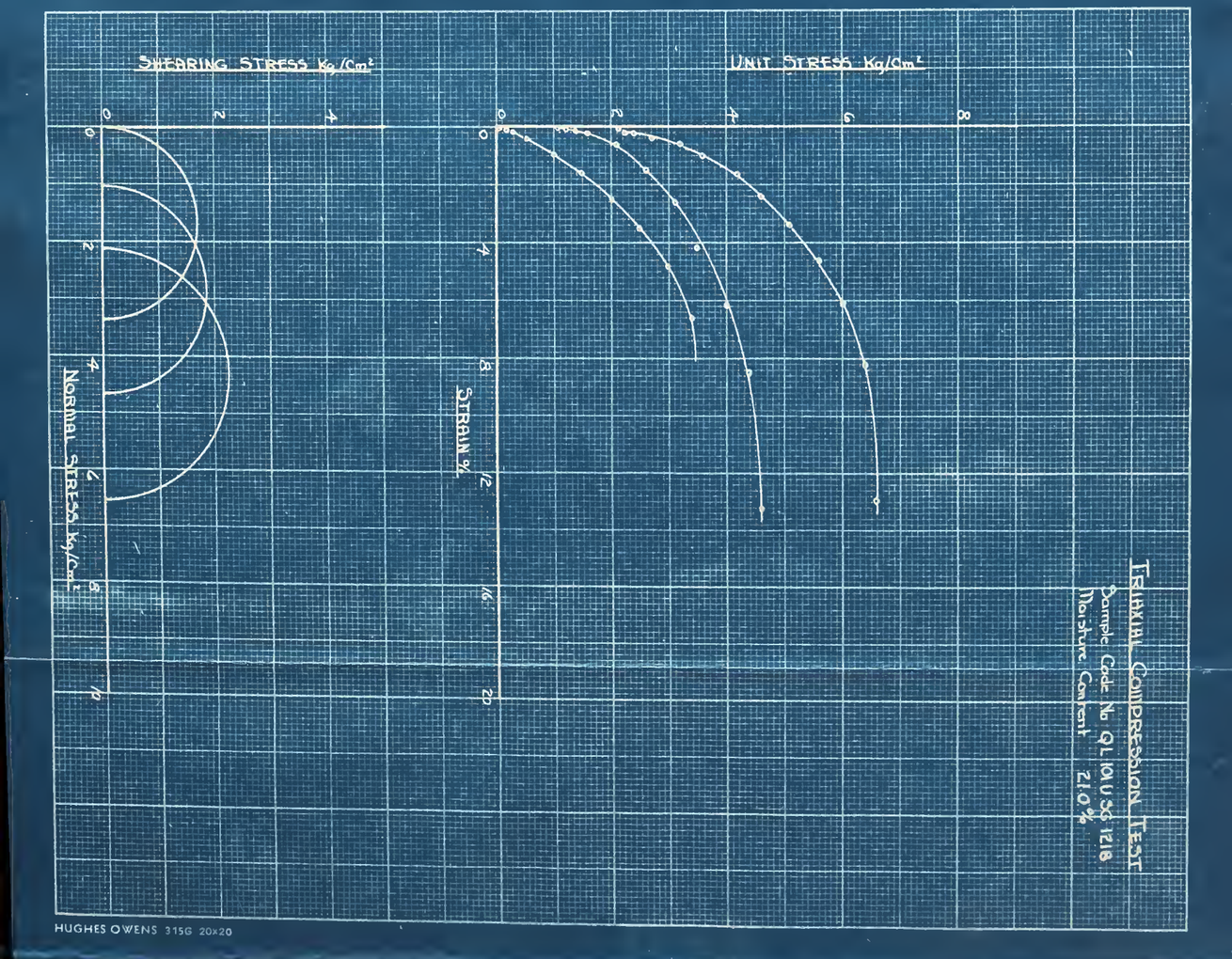
Moisture Content 12.3%



HUGHES OWENS 315G 20x20



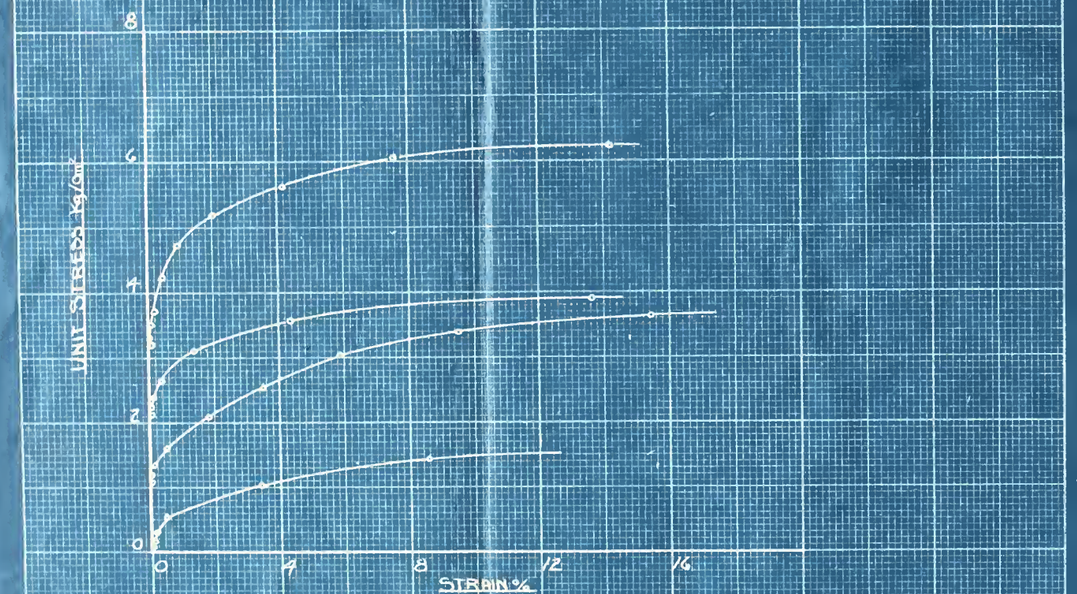
HUGHES OWENS 315G 20x20

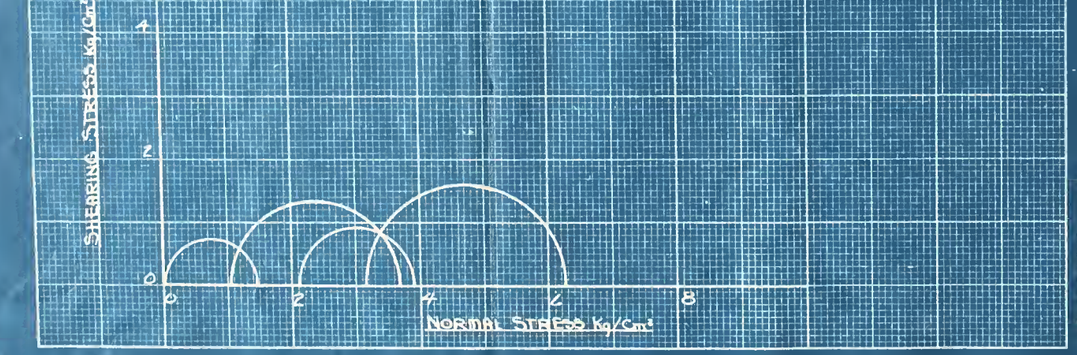


HUGHES OWENS 315G 20x20

TRIAXIAL COMPRESSION TEST

Sample Code No QL 101 U SG 1218
Moisture Content 24.2%



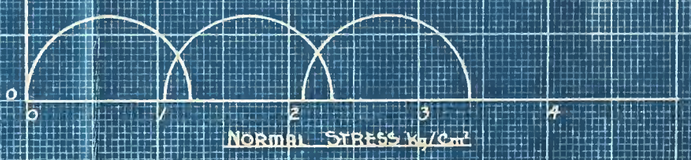


TRIAXIAL COMPRESSION TEST

Sample Code No QL 101 U SG 1218

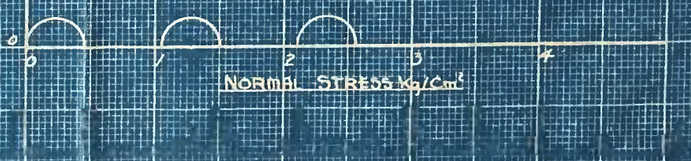
Note Enlarged Scale

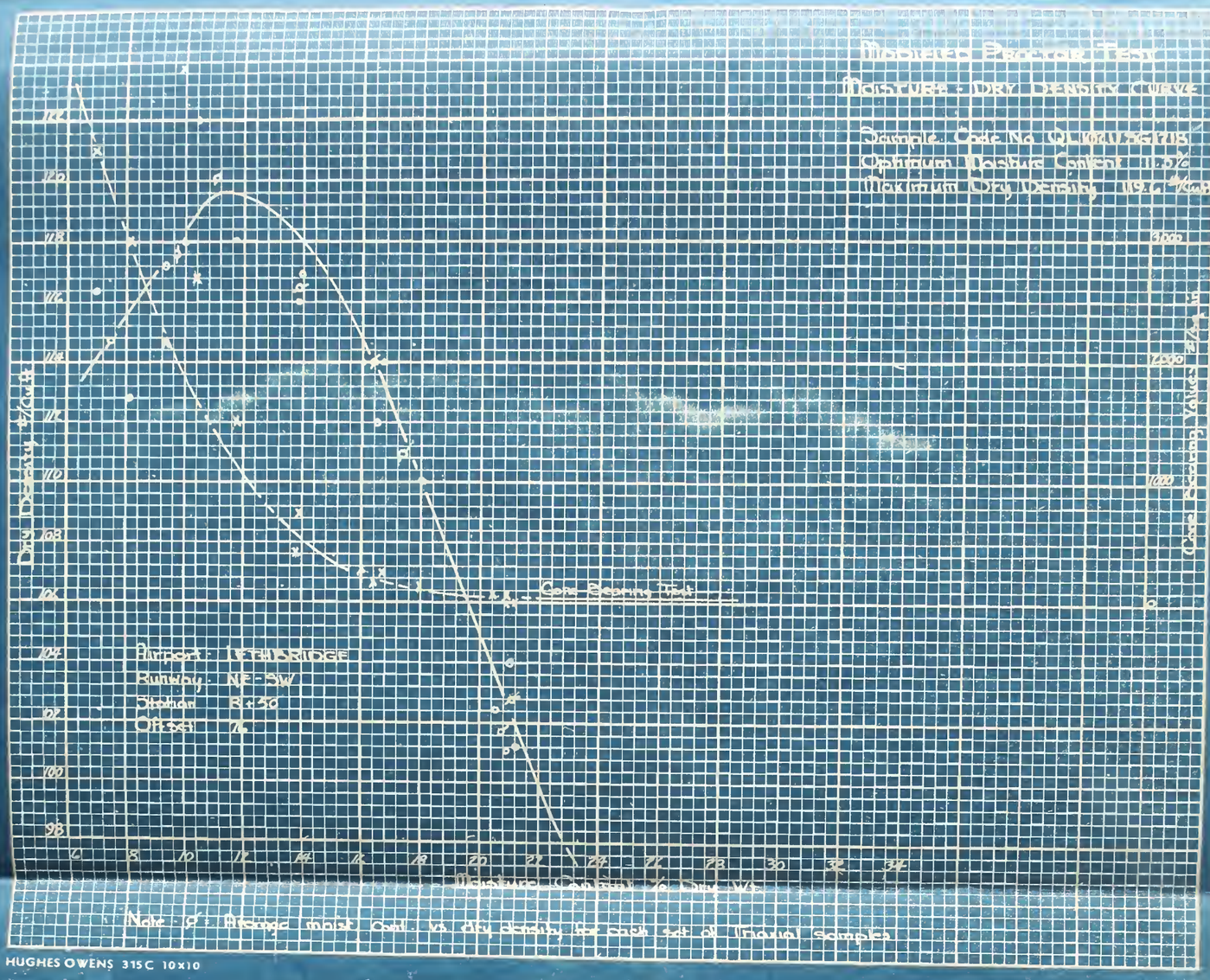
Moisture Content 28.5%
Dry Density 92.5 #/Cu ft = 89.1% Max



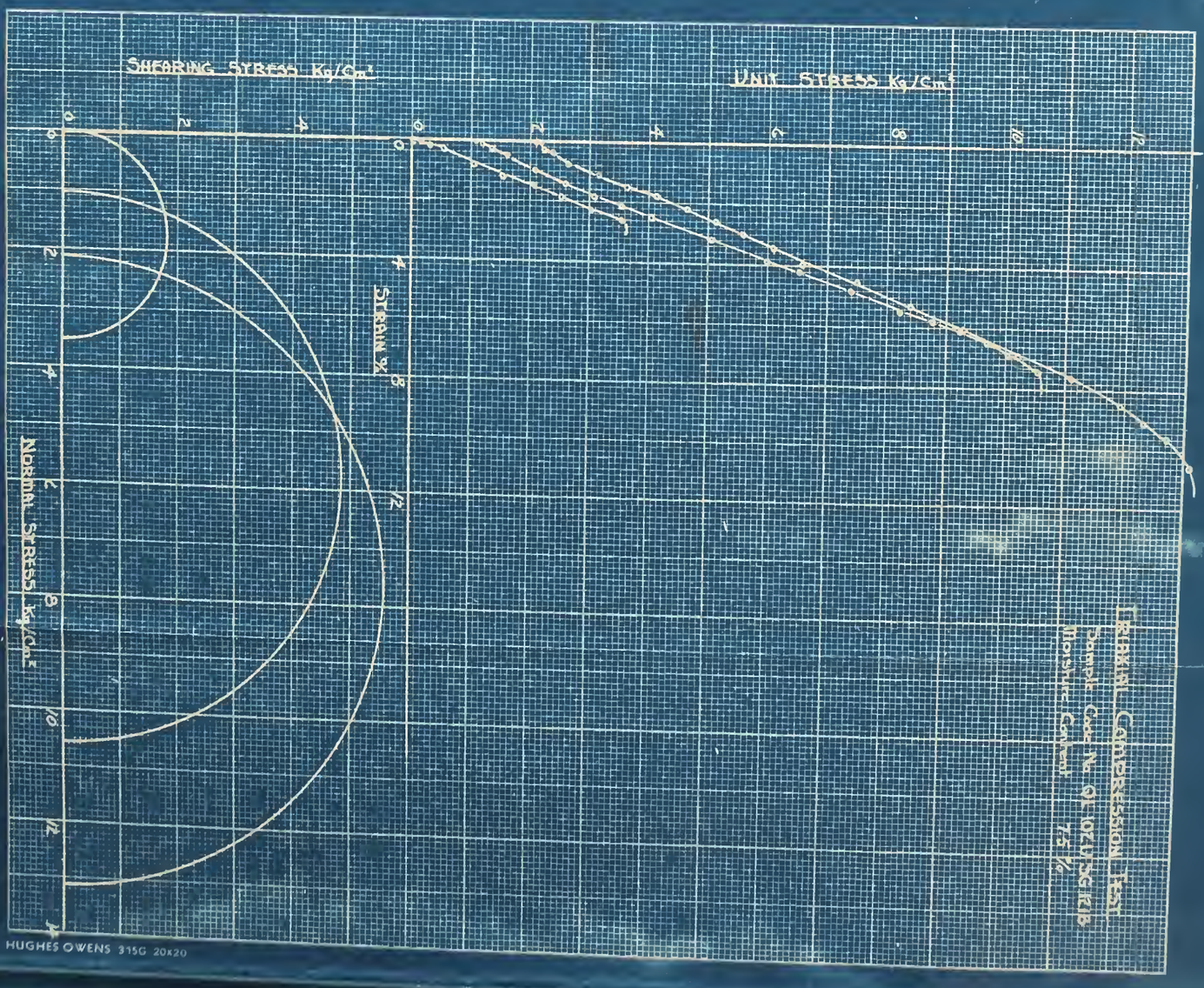
Moisture Content 31.9%
Dry Density 87.0 #/Cu ft = 83.8% Max

Moisture Content 35.5%
Dry Density = 81.2 #/Cu ft = 78.3% Max

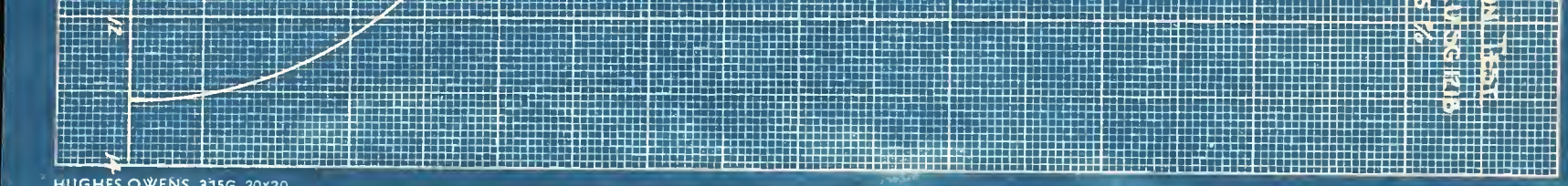


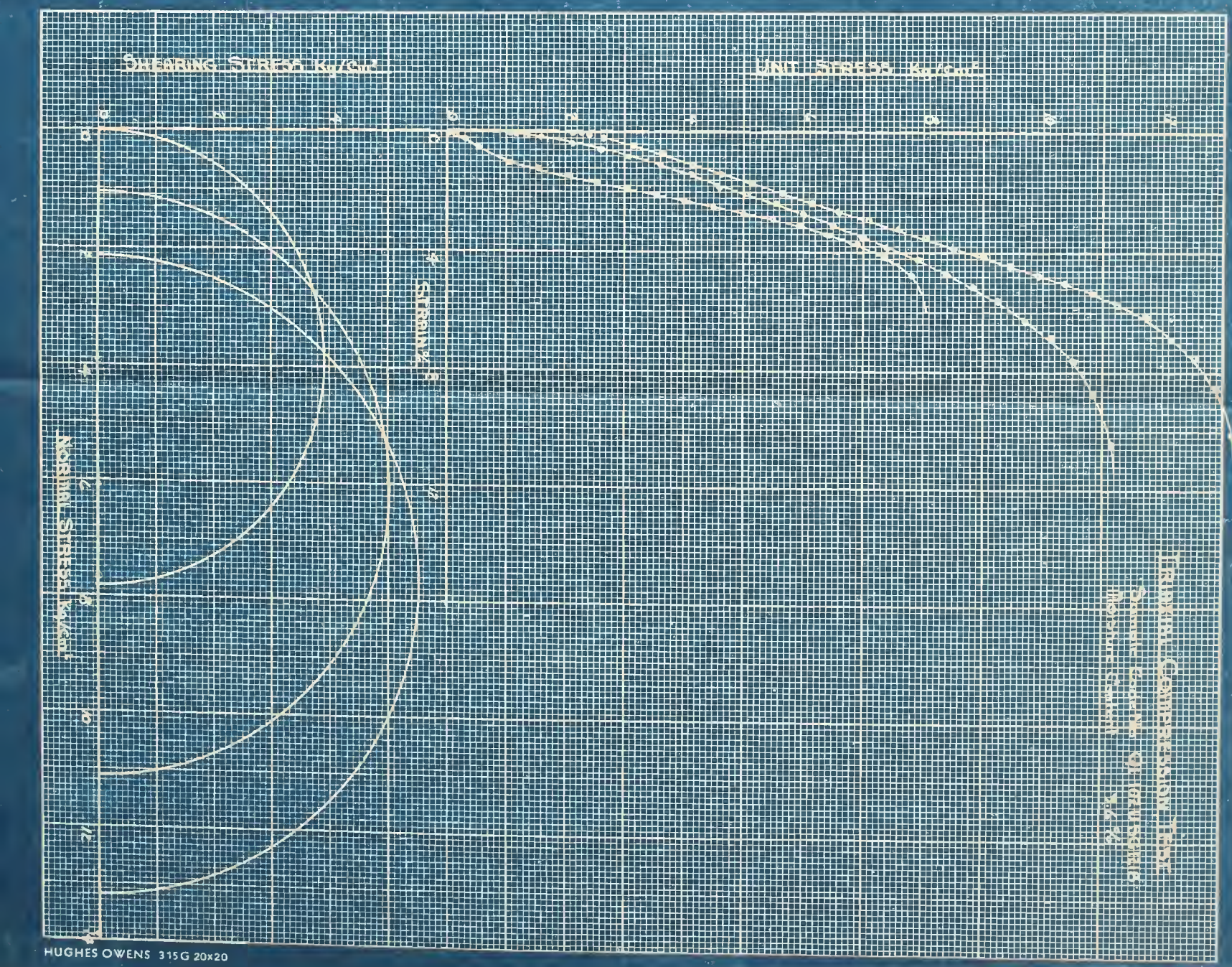

Modified Proctor Test
Moisture - Dry Density Curve
Sample Code No. QL/W/SK/718
Optimum Moisture Content 11.5%
Maximum Dry Density 112.4 lb/cub
Dry Density lb/cub ft
Cone Bearing Values tons/sq ft
Moisture Content %
Cone Bearing Test
Airport: LETHBRIDGE
Runway: NE-SW
Station 8+50
Offset 7%
Note: Average moist. cont. vs dry density for each set of Undrained Samples

HUGHES OWENS 315C 10x10



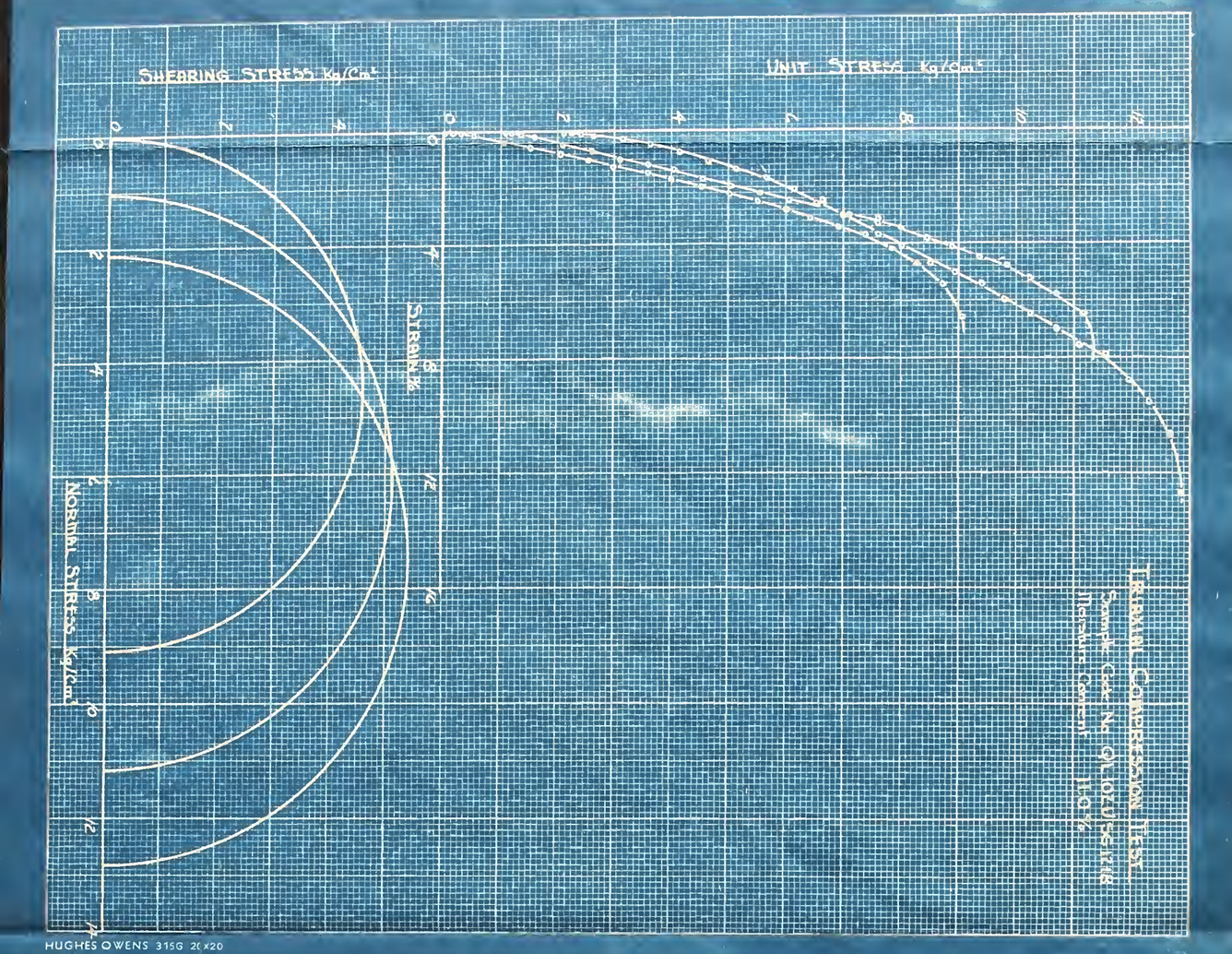
HUGHES OWENS 315G 20x20


HUGHES OWENS 315G 20x20

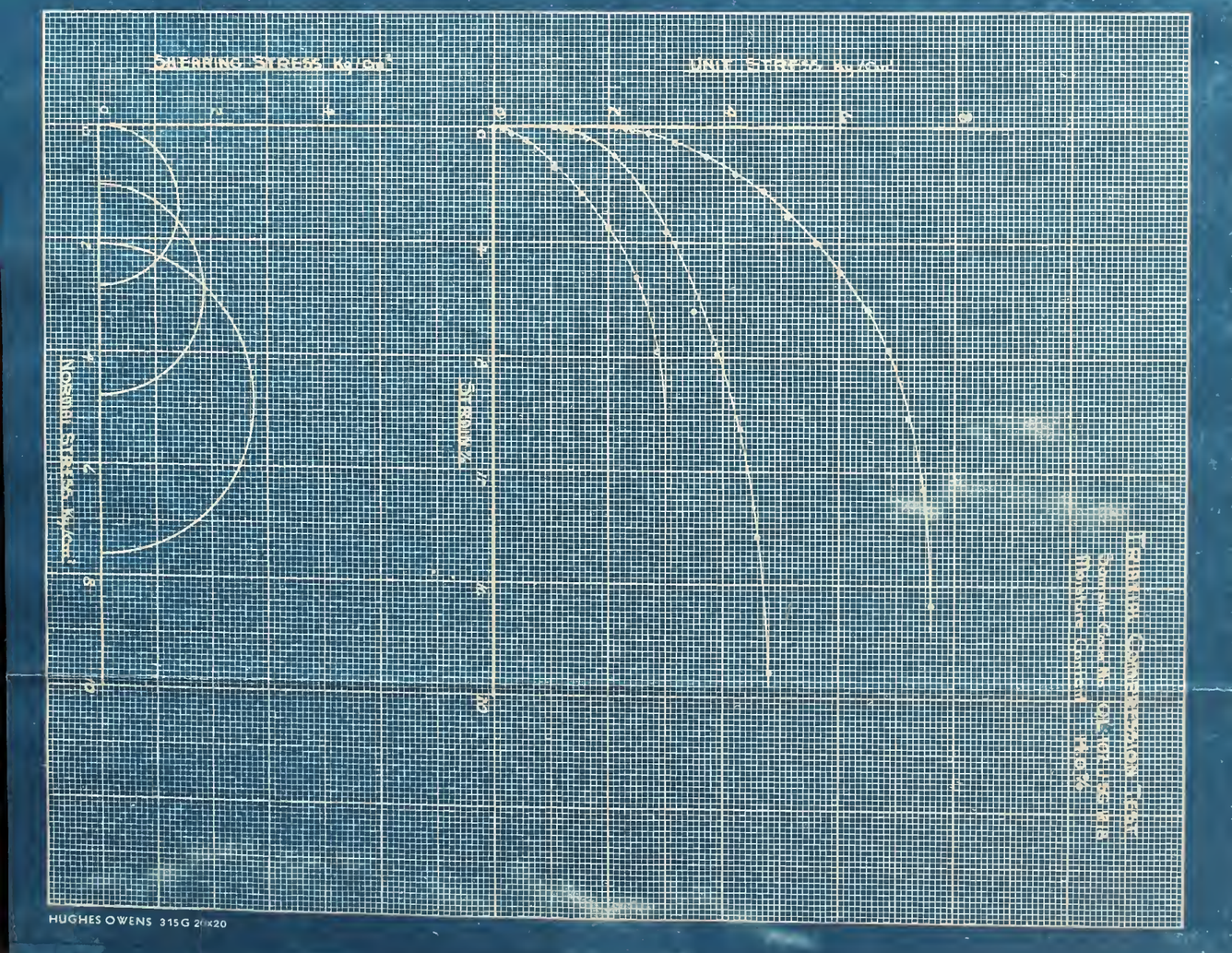

SHEARING STRESS Kg/Cm²
UNIT STRESS Kg/Cm²
NORMAL STRESS Kg/Cm²
HUGHES OWENS 315G 20x20

SHEARING STRESS Kg/Cm²
UNIT STRESS Kg/Cm²

HUGHES OWENS 315G 20x20



HUGHES OWENS 315G 20x20

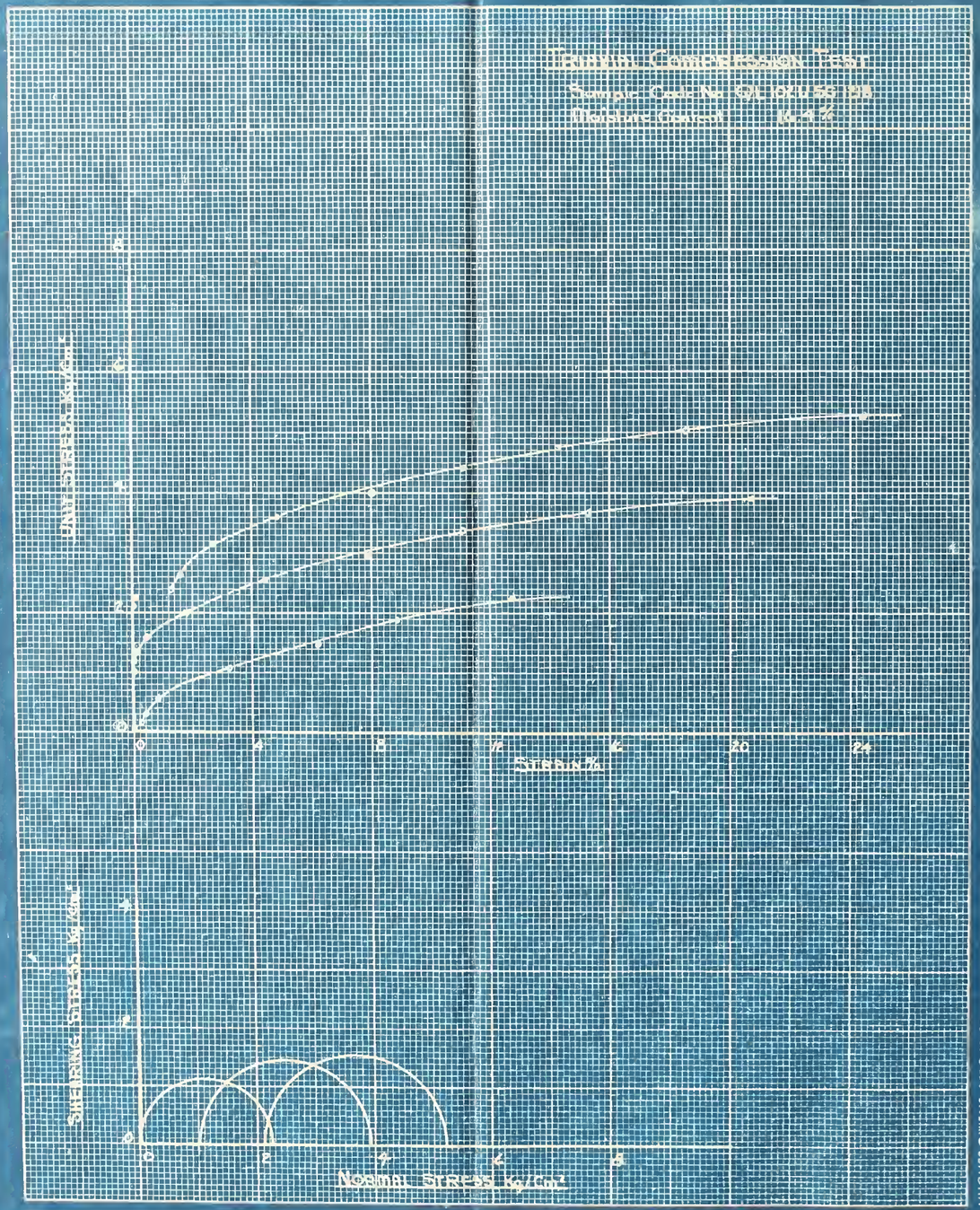


HUGHES OWENS 315G 20x20

Triaxial Compression Test

Sample Code No. QL102 U 5G 1218

Moisture Content 16.4%



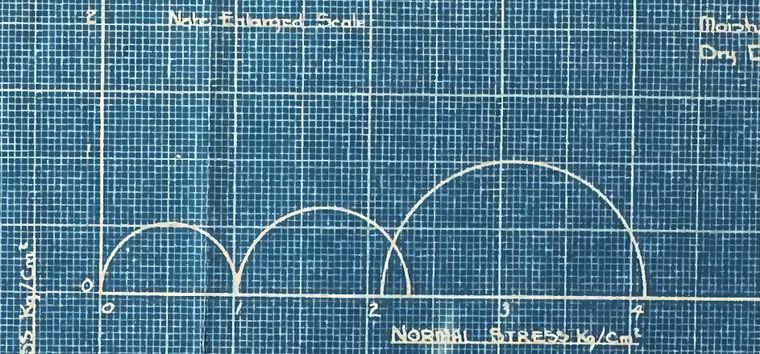
HUGHES OWENS 315G 20x20

Triaxial Compression Test

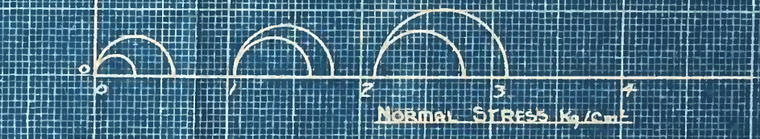
Sample Code No. QL102 U 5G 1218

Note Enlarged Scale

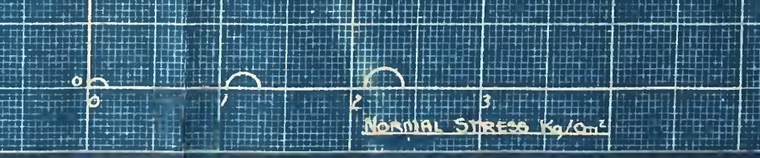
Moisture Content 17.3%
Dry Density 111 #/Cu.ft = 93.8% max.



Moisture Content 21.0%
Dry Density 102.2 #/Cu.ft = 85.6% max.



Moisture Content = 27.0%
Dry Density 91.8 #/Cu.ft = 76.8% max.



HUGHES OWENS 315G 20x20

Undrained Triaxial Test

Moisture Content Dry Density of Cylinder

Sample Bore No. Ground Level

Ordnance Datum Moisture Content

Maximum Dry Density

Date Reading Values Taken

Time Scale

Axial Strain %

Pore Pressure Kg/cm²

Cell Pressure Kg/cm²

Deviator Stress Kg/cm²

Effective Principal Stress Ratio

Effective Minor Principal Stress Kg/cm²

Effective Major Principal Stress Kg/cm²

Moisture Content % Dry Wt.

Dry Density Kg/m³

Effective Stress Paths

Mohr Circles Kg/cm²

Shearing Stress Kg/cm²

Normal Stress Kg/cm²

Strain %

Triaxial Compression Test

Sample Core No. Depth

Moisture Content 7.8%

Unit Stress Kg/cm²

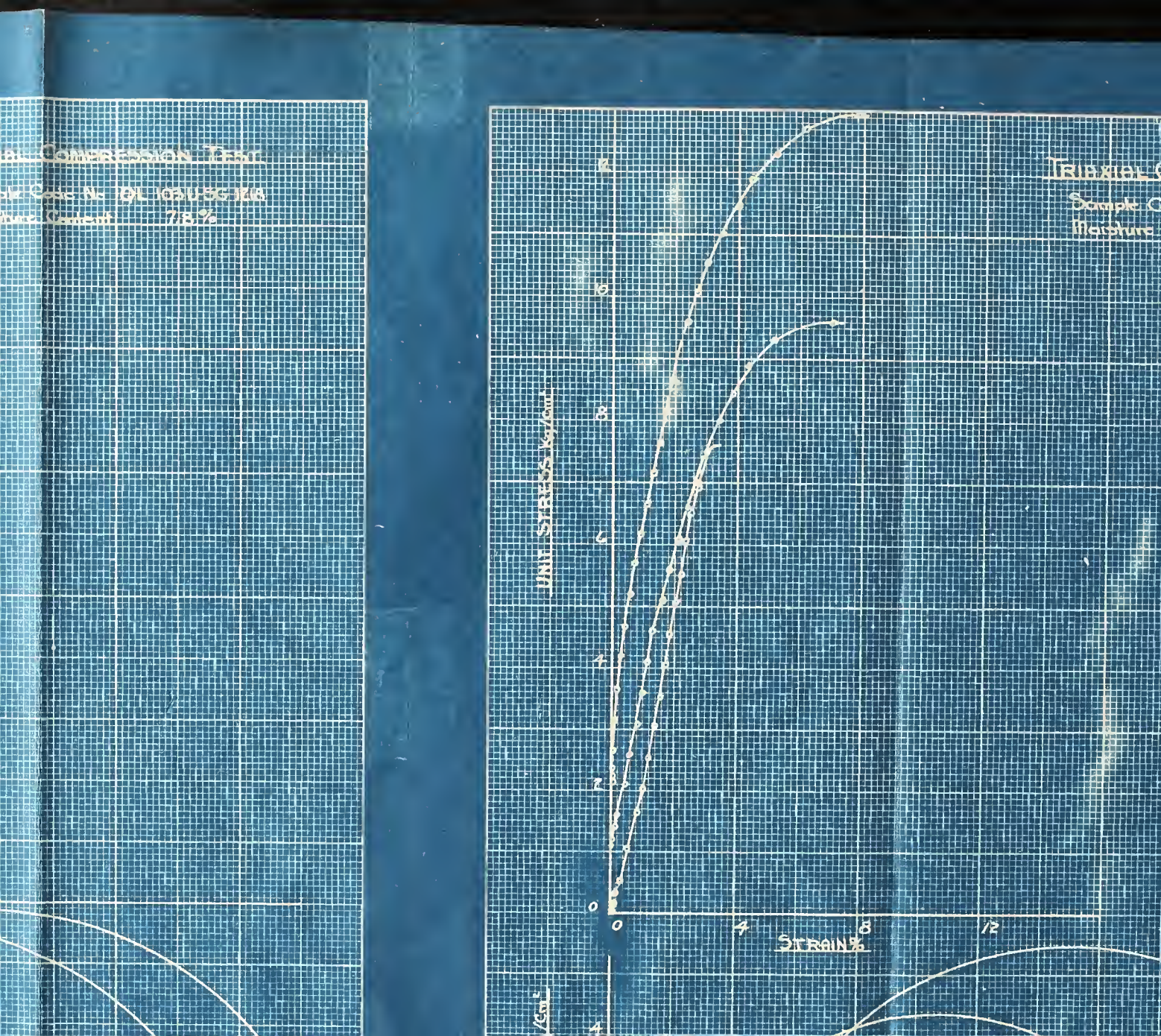
Shearing Stress Kg/cm²

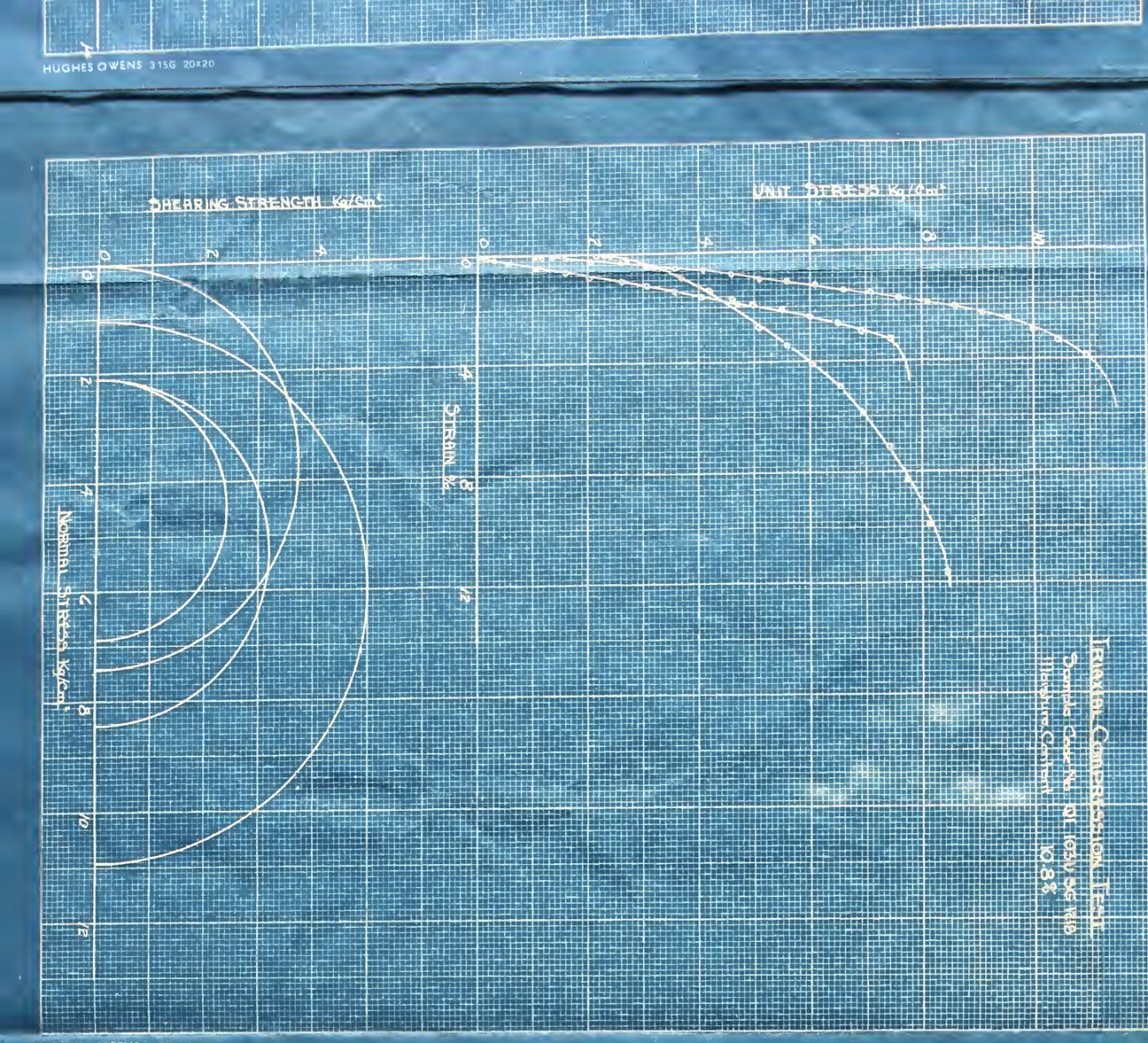
Normal Stress Kg/cm²

Strain %

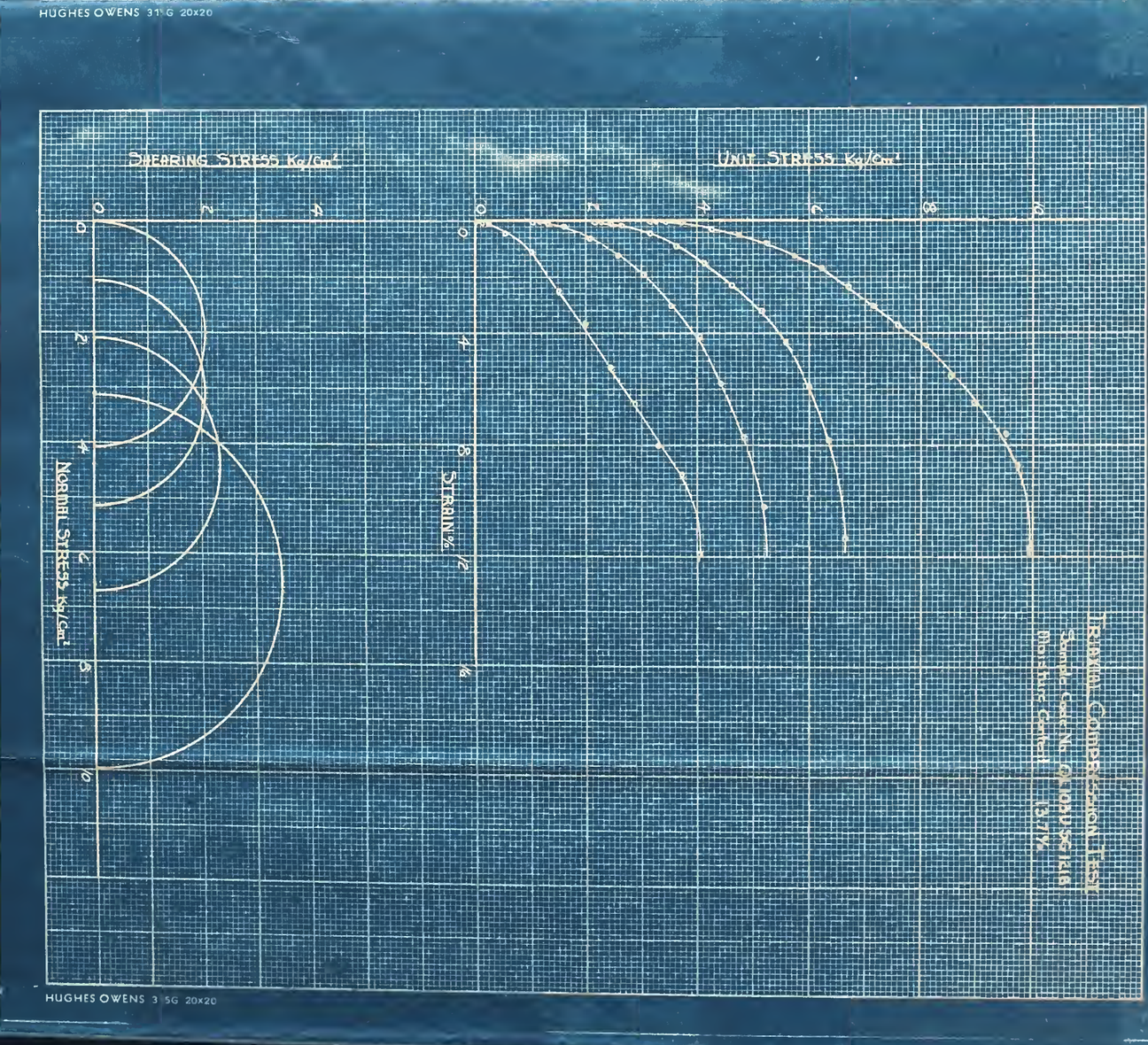
HUGHES OWENS 315C 10x10

HUGHES OWENS 315G 20x20

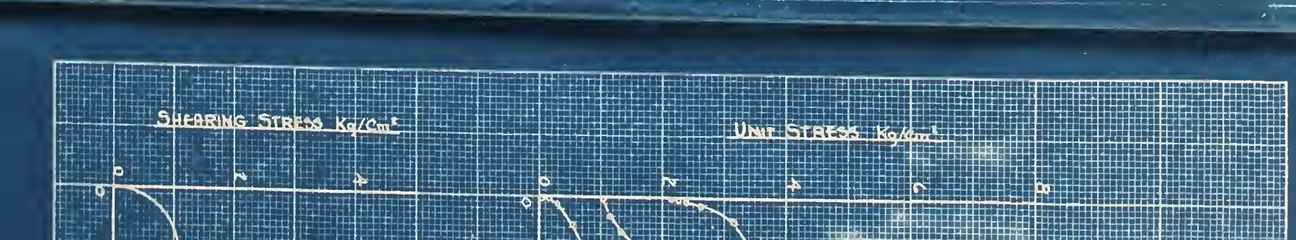

Compression Test
Case No. 101 Series 1218
Content 7.8%
Triaxial
Sample
Moisture
Unit Stress kg/cm²
0
2
4
6
8
10
12
0
4
8
12
Strain %



HUGHES OWENS 315G 20x20

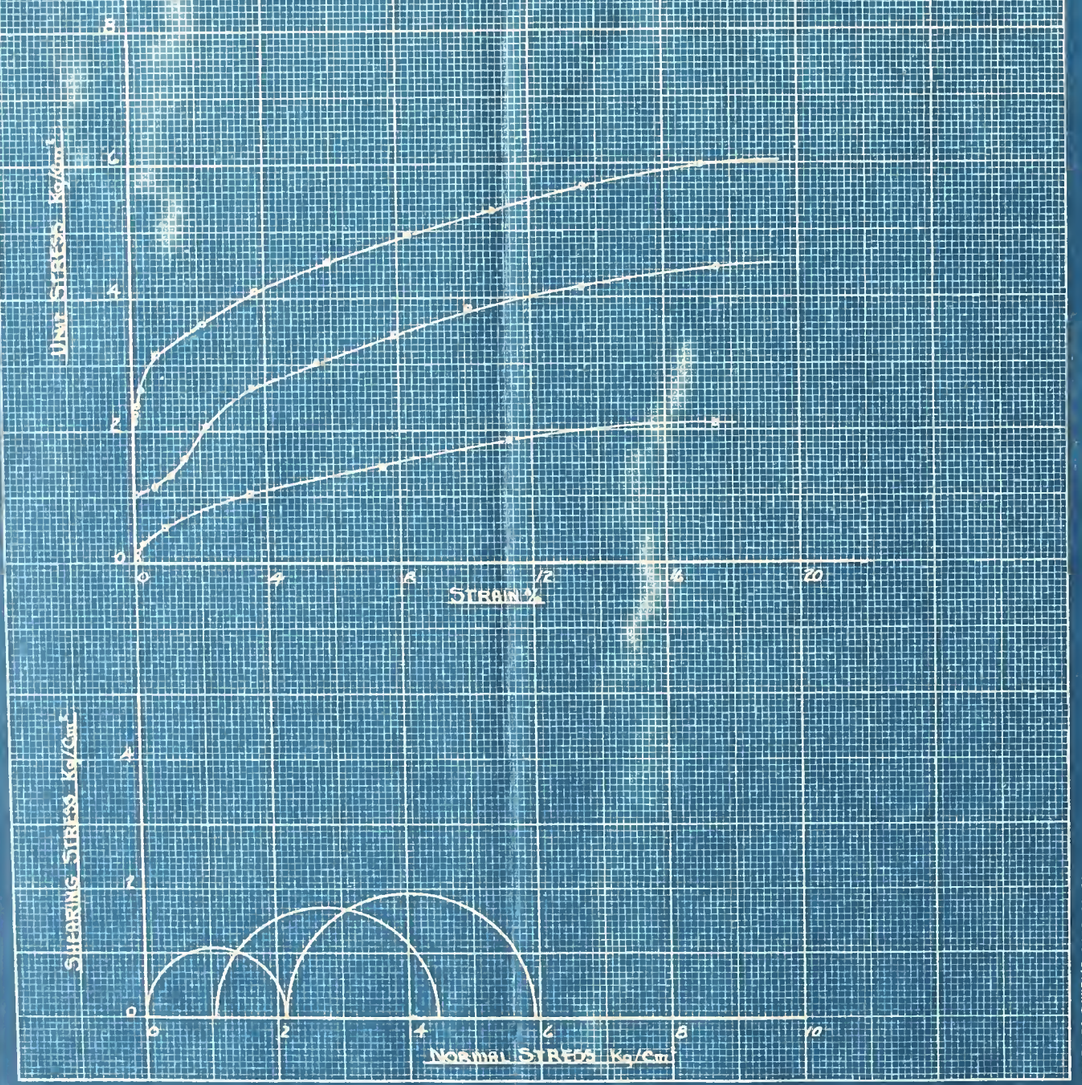


HUGHES OWENS 315G 20x20



Triaxial Compression Test

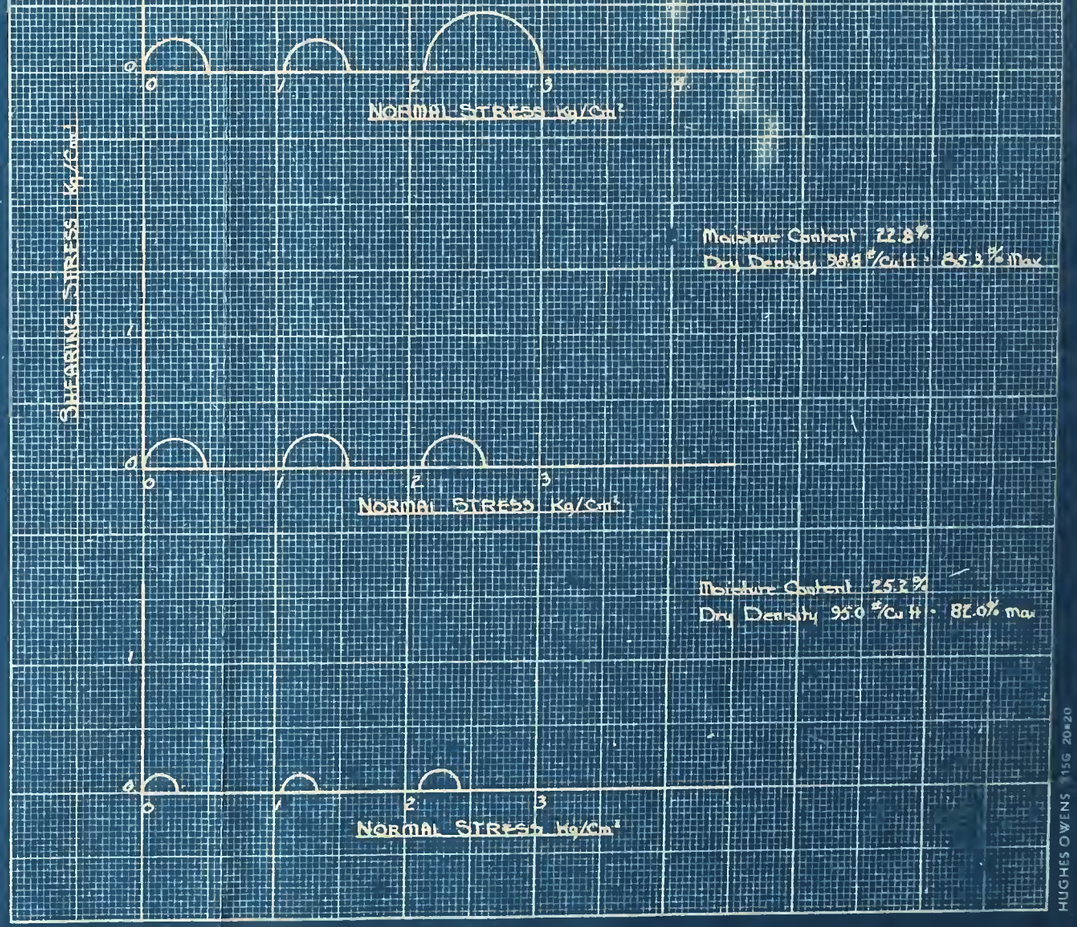
Sample Code No. 01/65/W/SG 12/8
Moisture Content 15.9%



Triaxial Compression Test

Sample Code No. 01/65/W/SG 12/8

Note Enlarged Scale



Moisture Content 20.4%
Dry Density 104 #/Cu ft = 85.8% max

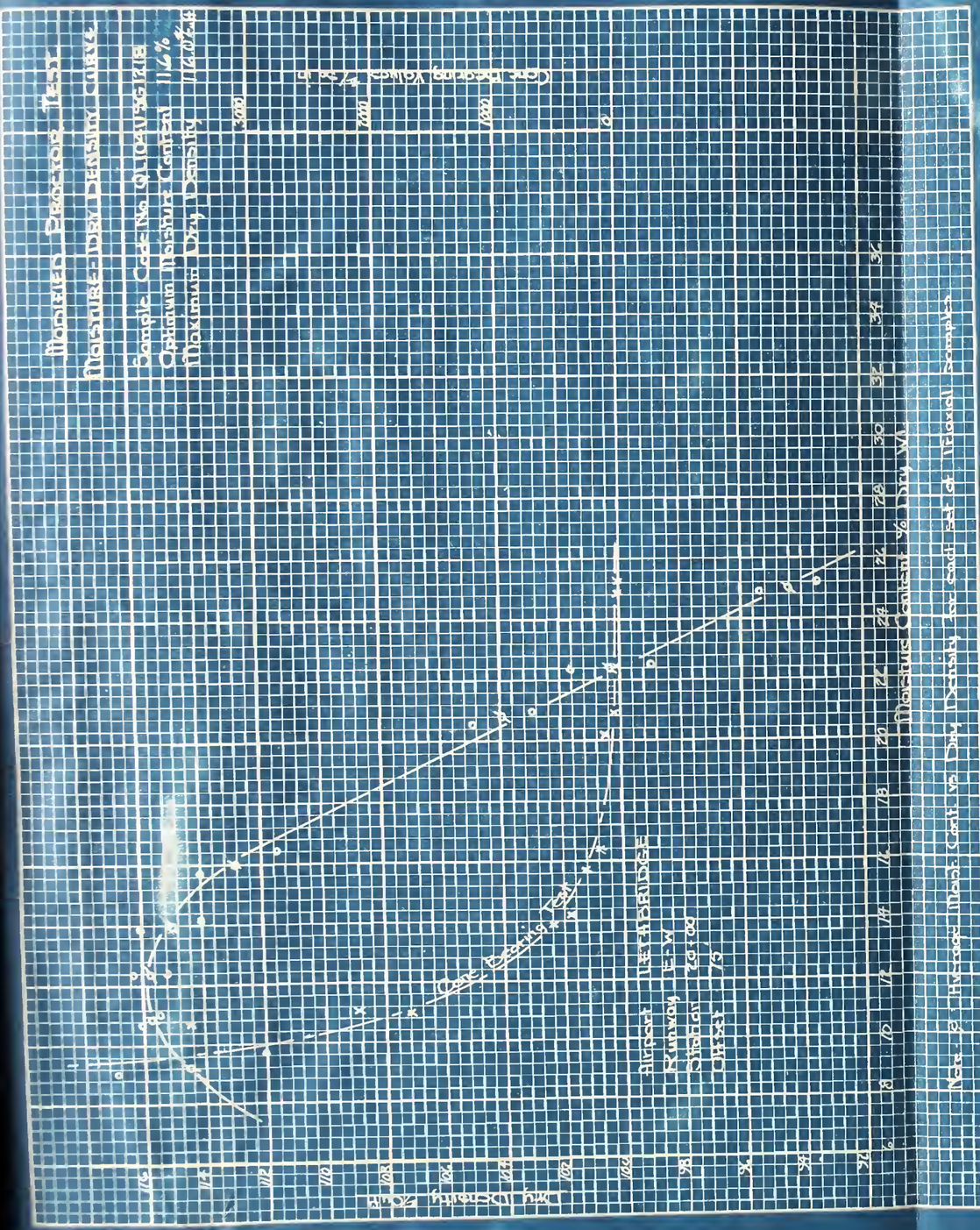
Moisture Content 22.8%
Dry Density 98.9 #/Cu ft = 85.3% max

Moisture Content 25.2%
Dry Density 93.0 #/Cu ft = 87.0% max

Modified Proctor Test

Moisture-Unit Weight Curve

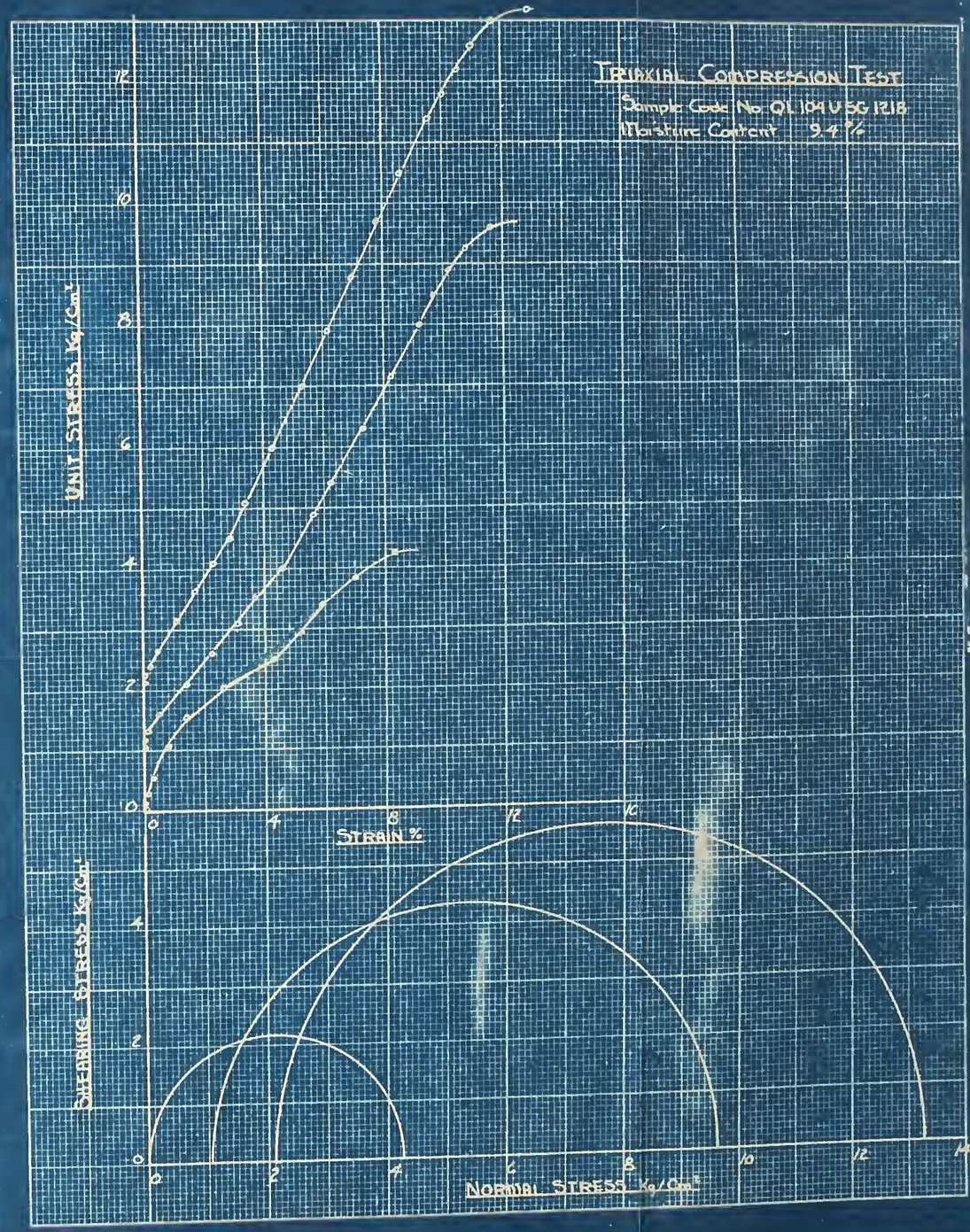
Sample Code No. QL104 V SG 1218
Optimum Moisture Content 11.2%
Maximum Dry Density 1.740 Gm/cc


Dry Density Gm/cc
Moisture Content %
Zero Air Voids Curve
Curve Showing Relationship between Moisture Content and Dry Density for Different Compactive Efforts
Dry Density Gm/cc
Moisture Content %

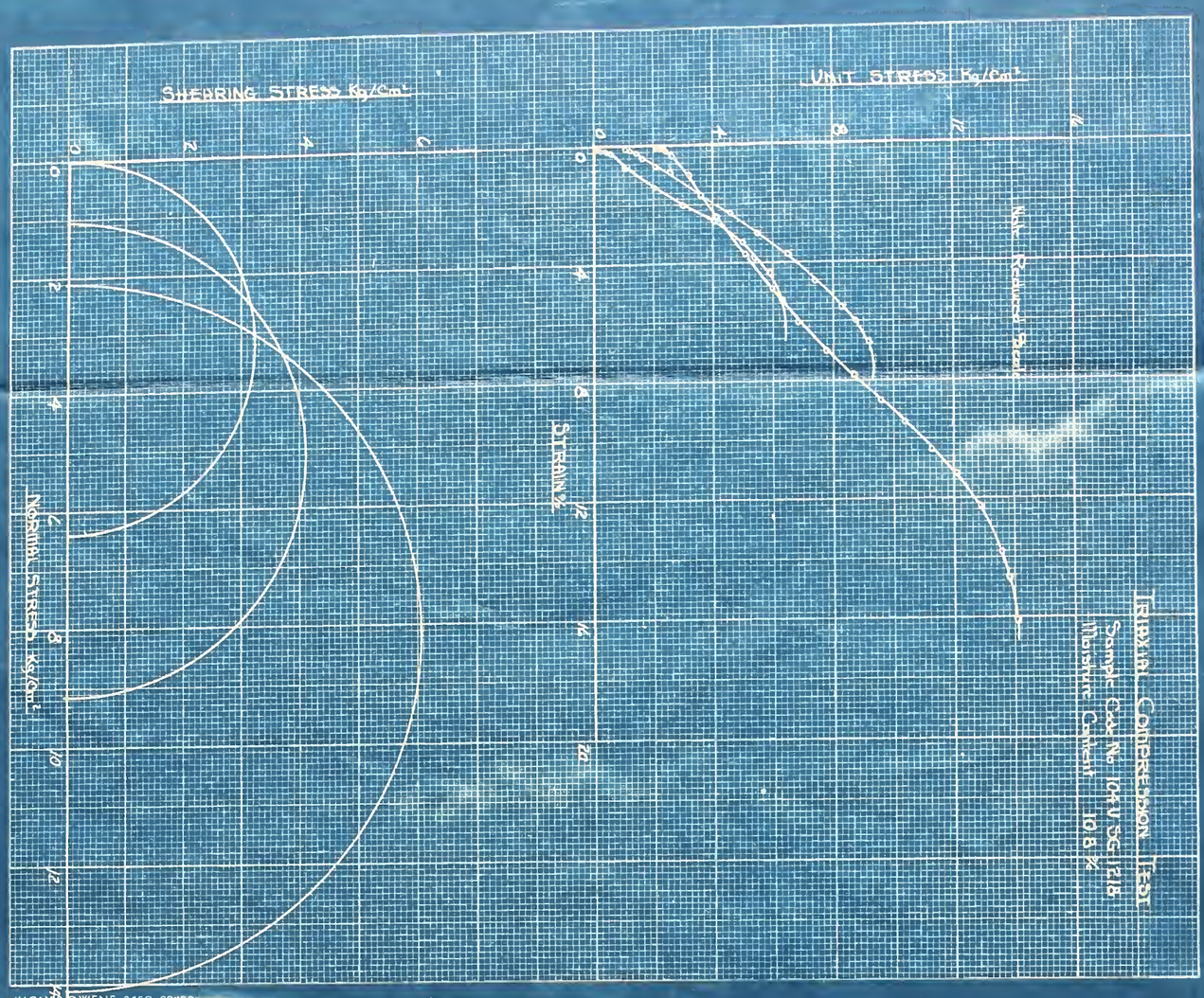
HUGHES OWENS 315C 10x10

Triaxial Compression Test

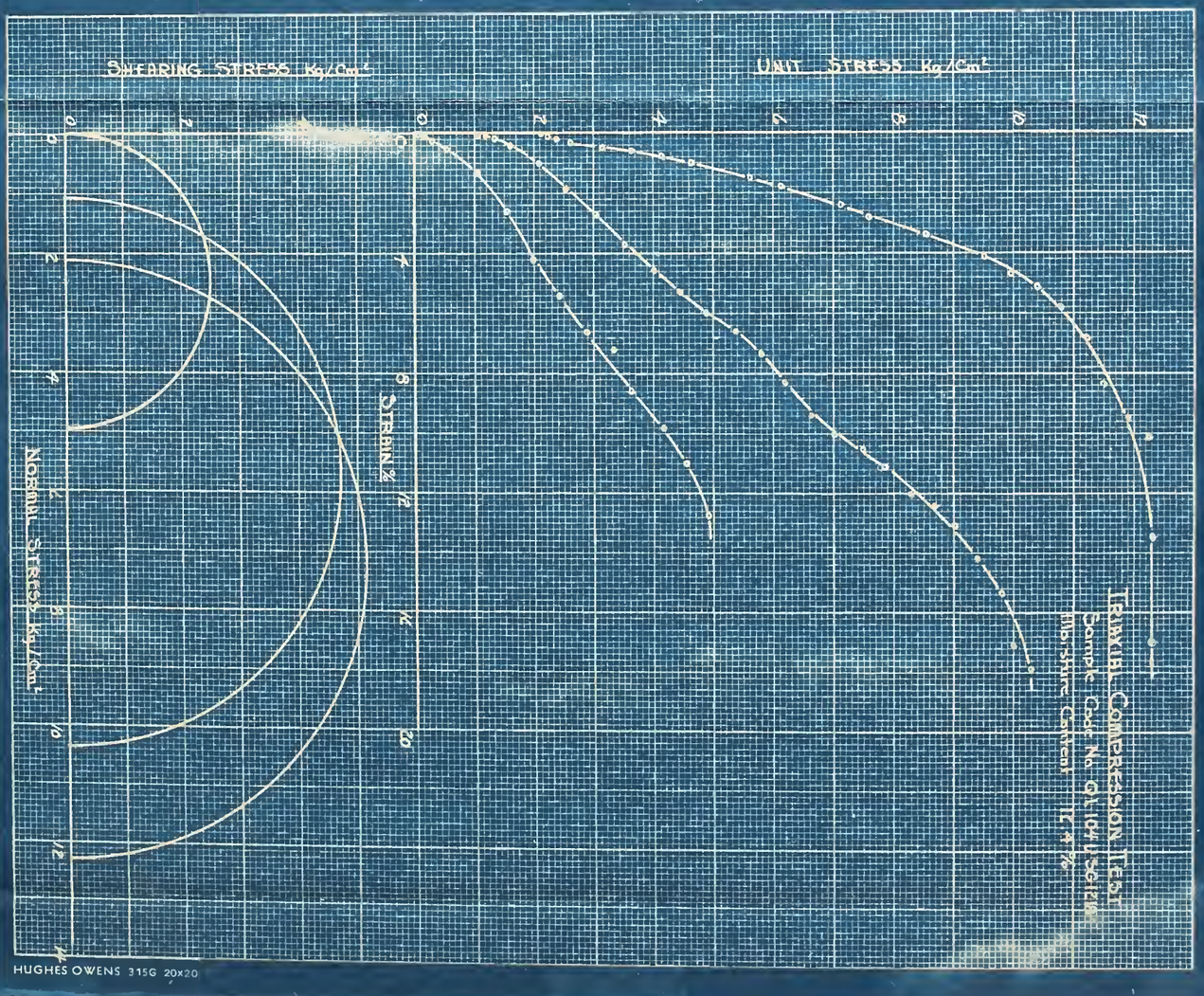
Sample Code No. QL104 V SG 1218
Moisture Content 9.4%



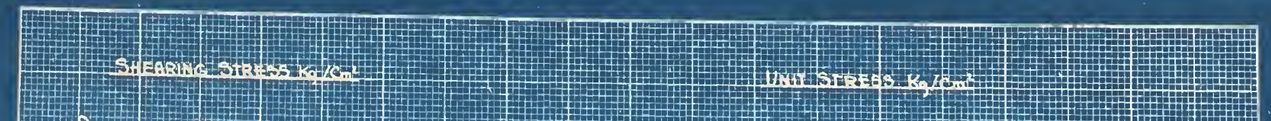
HUGHES OWENS 315G 20x20

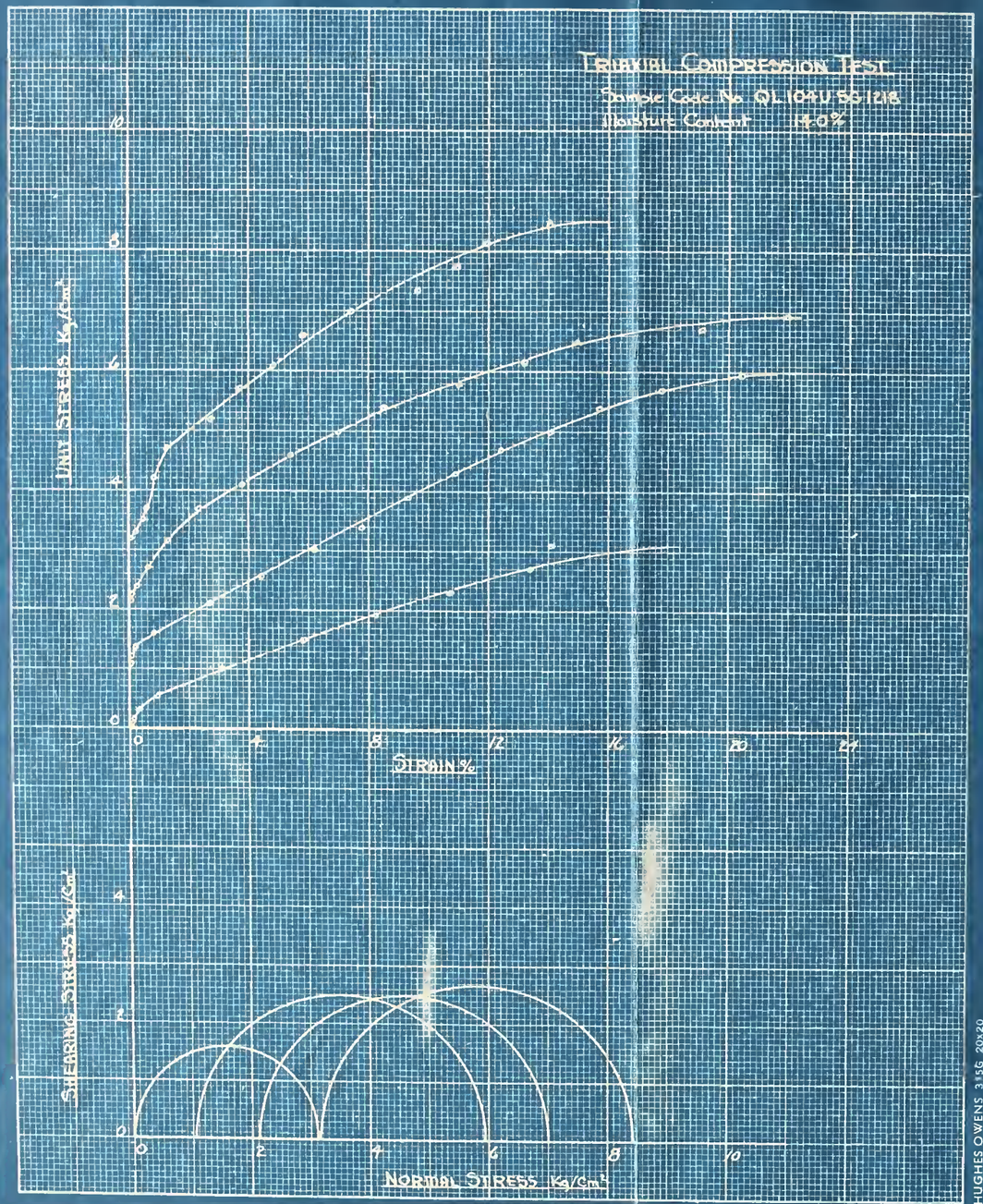


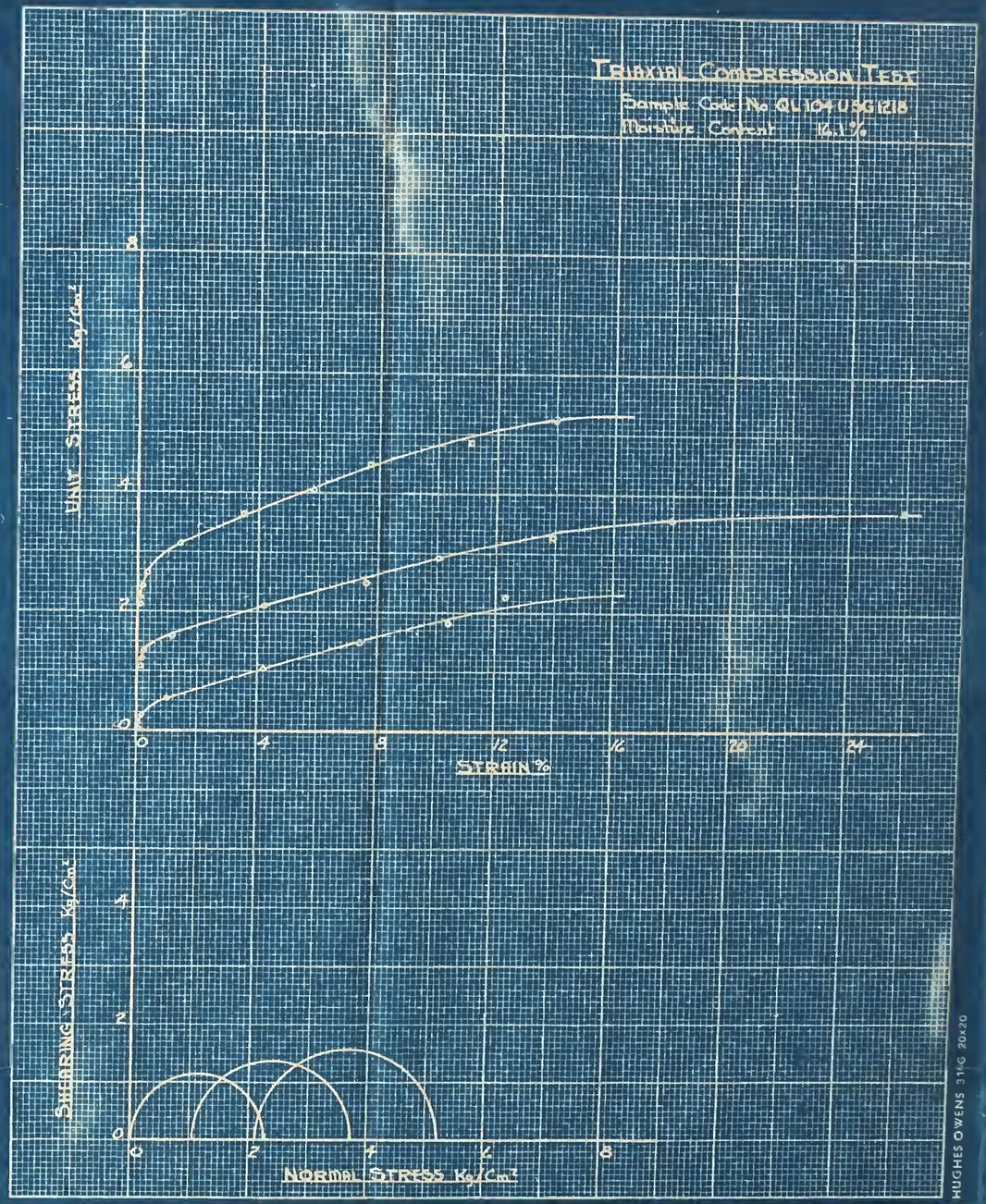
HUGHES OWENS 315G 20x20



HUGHES OWENS 315G 20x20



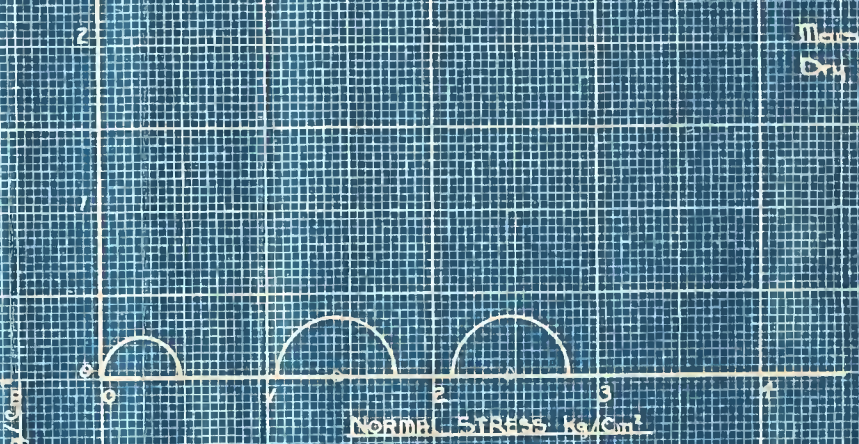

TRIAXIAL COMPRESSION TEST
Sample Code No. QL1041U SG1218
Moisture Content 14.0%
UNIT STRESS Kg/Cm²
STRAIN %
SHEARING STRESS Kg/Cm²
NORMAL STRESS Kg/Cm²


TRIAXIAL COMPRESSION TEST
Sample Code No. QL1041U SG1218
Moisture Content 16.1%
UNIT STRESS Kg/Cm²
STRAIN %
SHEARING STRESS Kg/Cm²
NORMAL STRESS Kg/Cm²

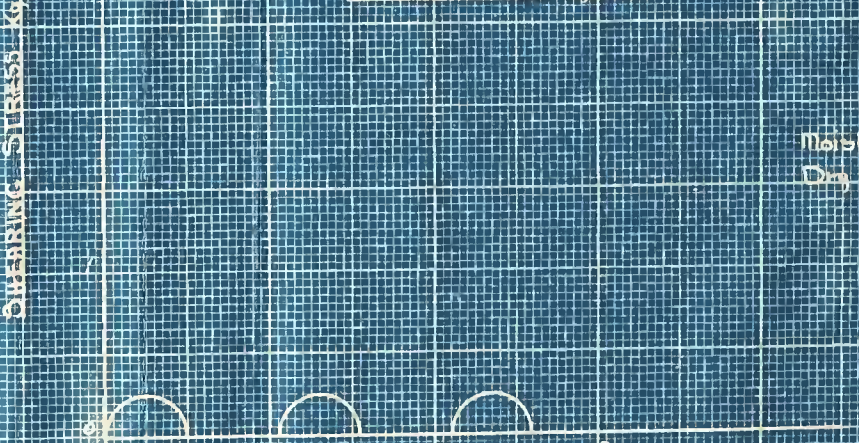
TRIAXIAL COMPRESSION TEST

Sample Code No. QU104/SG1218

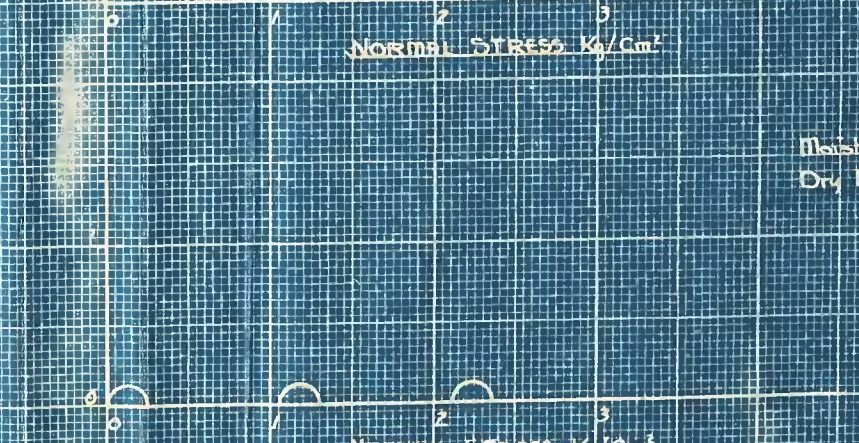
Note: Exaggerated Scale



Moisture Content 20.7 %
Dry Density 104 #/Cu ft : 89.7% max.



Moisture Content 22.5%
Dry Density 100.3 #/Cu ft : 86.7% max



Moisture Content 25.0%
Dry Density 94.5 #/Cu ft = 81.5% max

HUGHES OWENS 315G 20X20

Water Content vs Compressive Strength

Modified Proctor Compaction

Sample Code No. QR 6U 3606:

- Lateral Pressure 0
- Lateral Pressure 15 psi
- Lateral Pressure 30 psi

Theoretical Comp. Strength at Liquid Limit

Moisture Content % Dry Weight

Compressive Strength (Lateral) kg/cm²

KEUFFEL & ESSER CO., N. Y. NO. 359-91.
Semi-Logarithmic, 4 Cycles X 10 to the Inch.
MADE IN U.S.A.

Water Content vs Compressive Strength

Modified Proctor Compaction

Sample Code No. QR 6U 3606:

- Lateral Pressure 0
- Lateral Pressure 15 psi
- Lateral Pressure 30 psi

Theoretical Comp. Strength at Liquid Limit

Moisture Content % Dry Weight

Compressive Strength

KEUFFEL & ESSER CO., N. Y. NO. 359-91.
Semi-Logarithmic, 4 Cycles X 10 to the Inch.
MADE IN U.S.A.

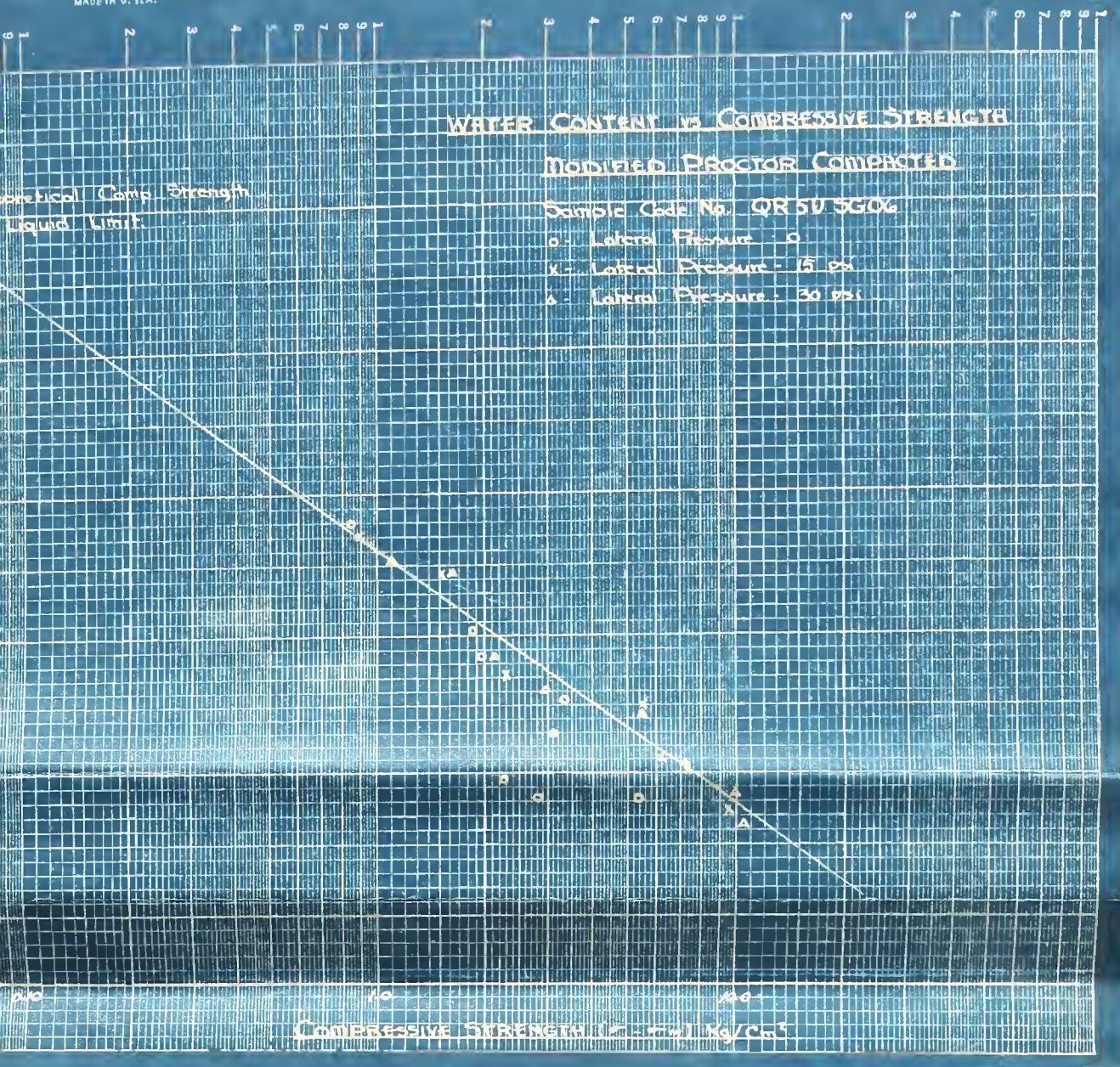
Water Content vs Compressive Strength

Modified Proctor Compaction

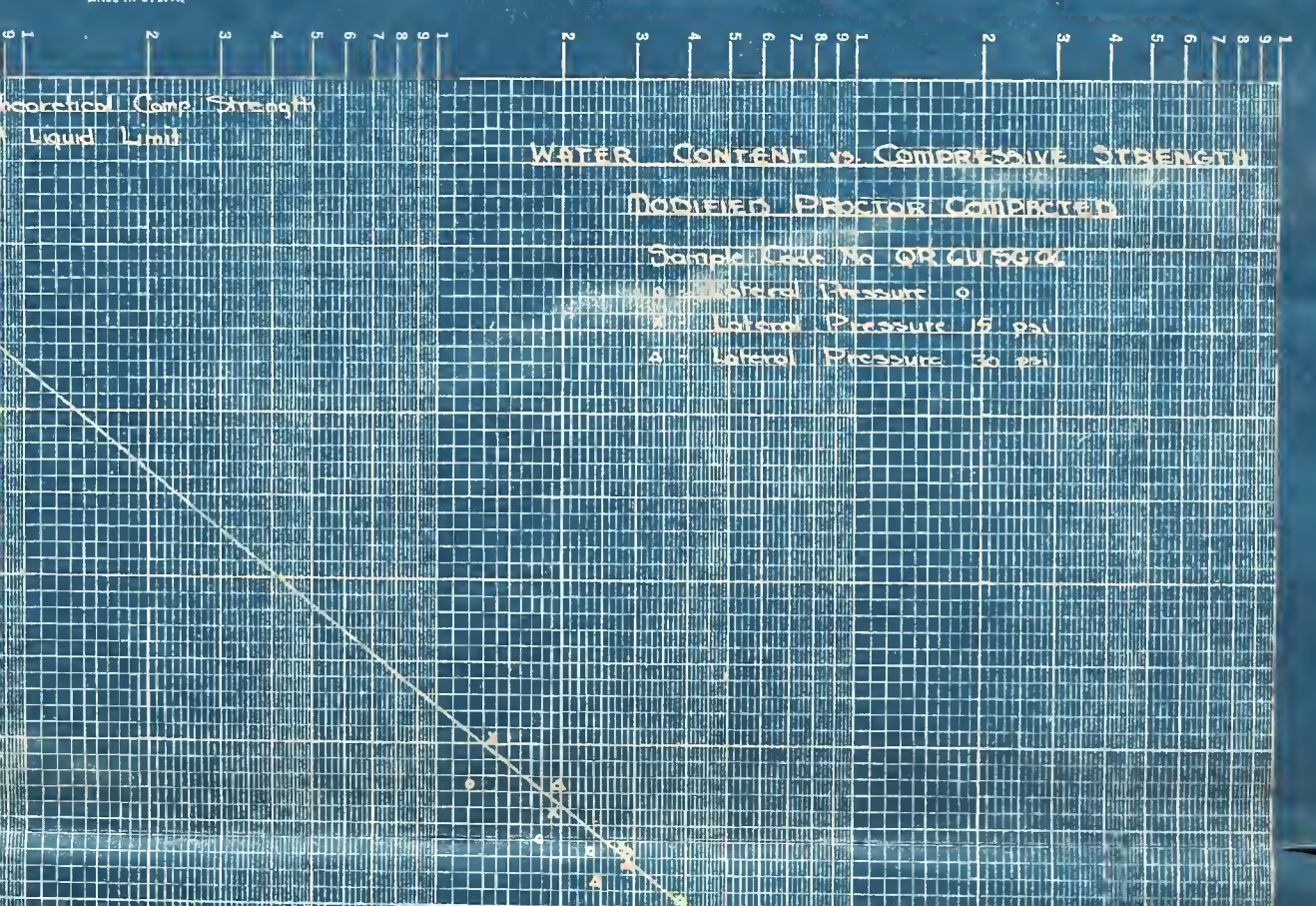
Theoretical Comp. Strength at Liquid Limit

KEUFFEL & ESSER CO., N. Y. NO. 359-91.
Semi-Logarithmic, 4 Cycles X 10 to the Inch.
MADE IN U.S.A.

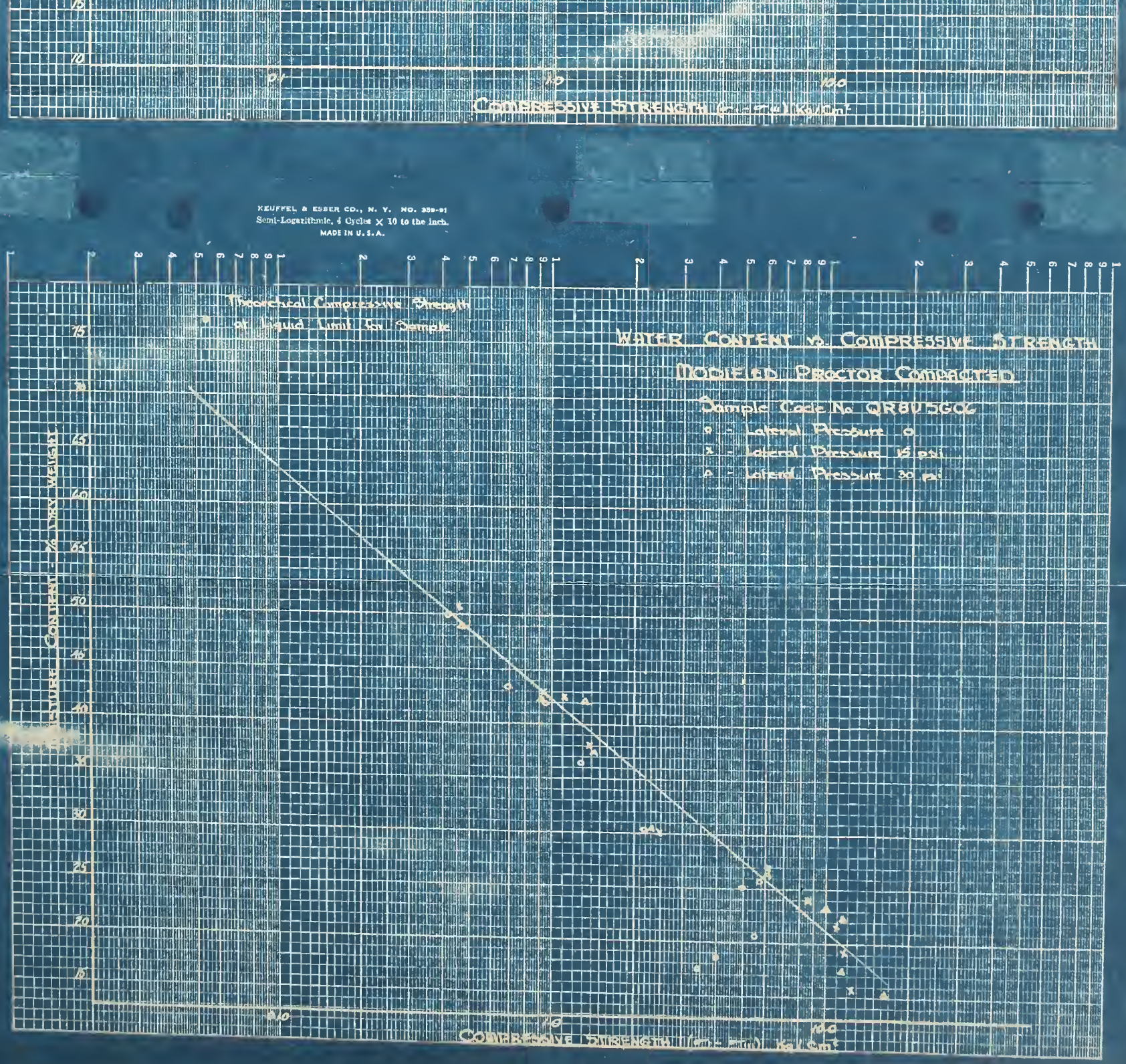
KEUFFEL & ESSER CO., N. Y. NO. 358-81
Semi-Logarithmic, 4 Cycles X 10 to the inch.
MADE IN U. S. A.

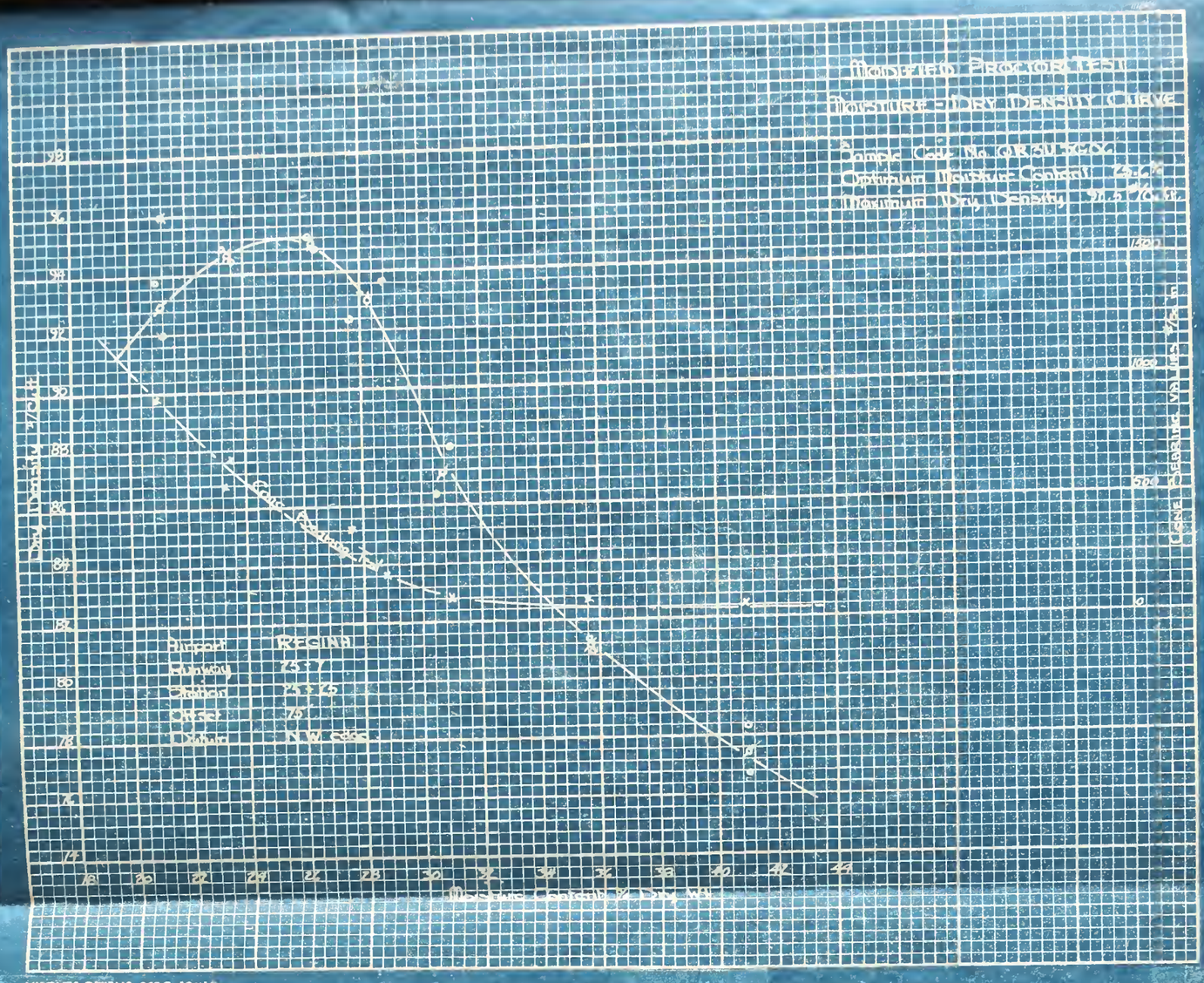

Theoretical Comp. Strength
Liquid Limit
WATER CONTENT vs COMPRESSIVE STRENGTH
MODIFIED PROCTOR COMPACTED
Sample Code No. QR 5U 5G04
o - Lateral Pressure 0
x - Lateral Pressure - 15 psi
Δ - Lateral Pressure - 30 psi
COMPRESSIVE STRENGTH (C - cu) Kg/cm²

KEUFFEL & ESSER CO., N. Y. NO. 358-81
Semi-Logarithmic, 4 Cycles X 10 to the inch.
MADE IN U. S. A.

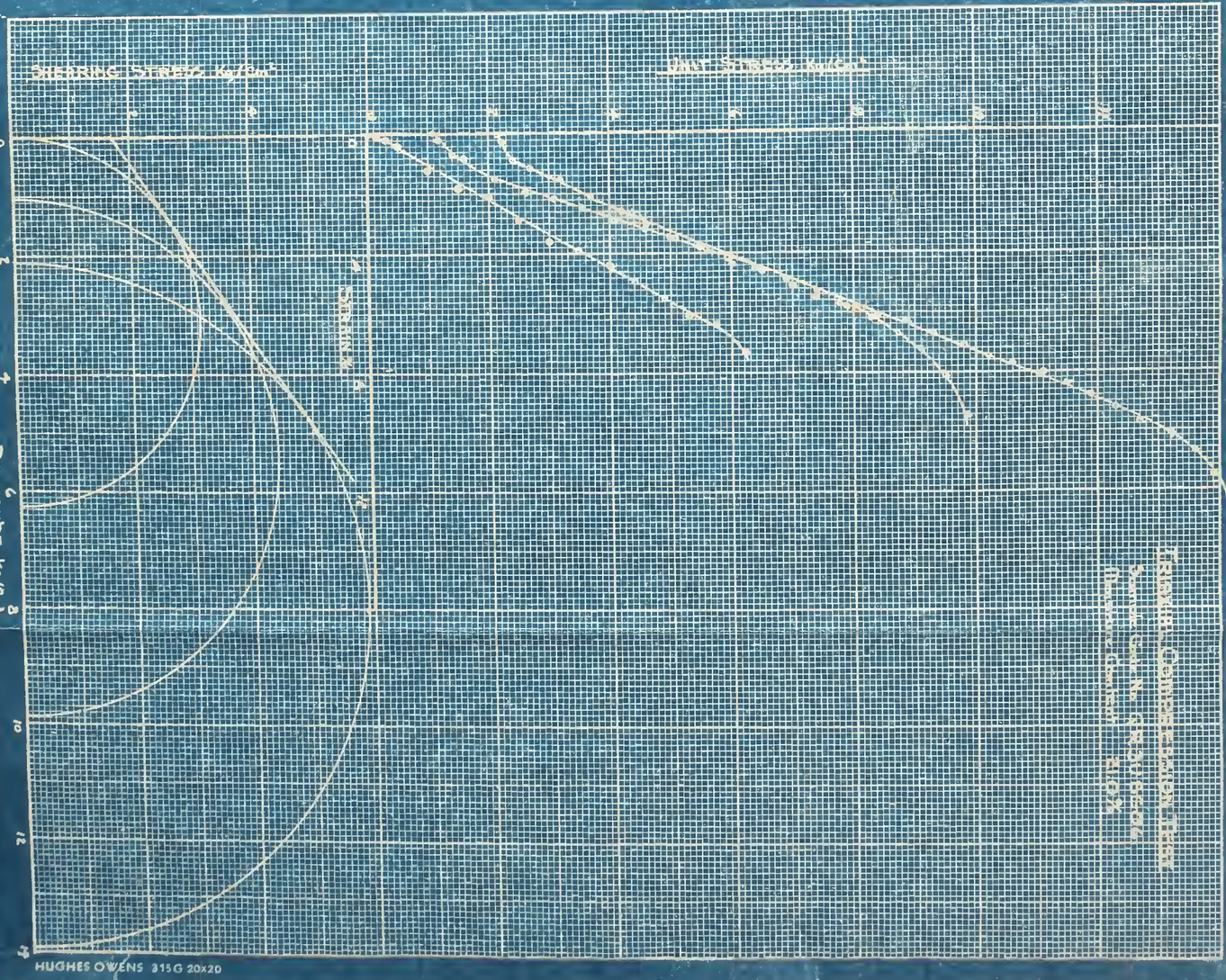

Theoretical Comp. Strength
Liquid Limit
WATER CONTENT vs COMPRESSIVE STRENGTH
MODIFIED PROCTOR COMPACTED
Sample Code No. QR 4U 5G04
o - Lateral Pressure 0
x - Lateral Pressure 15 psi
Δ - Lateral Pressure 30 psi

KEUFFEL & ESSER CO., N. Y. NO. 359-91
Semi-Logarithmic, 4 Cycles X 10 to the Inch.
MADE IN U.S.A.

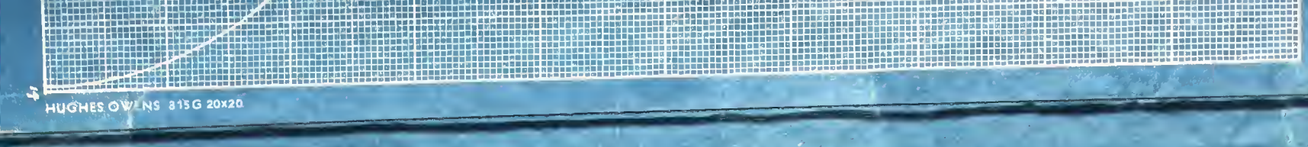

Theoretical Compressive Strength at Liquid Limit for Sample
WATER CONTENT vs. COMPRESSIVE STRENGTH
MODIFIED PROCTOR COMPACTED
Sample Code No. QR8U5G0L
○ - Lateral Pressure 0
× - Lateral Pressure 15 psi
△ - Lateral Pressure 30 psi
WATER CONTENT (% DRY WEIGHT)
COMPRESSIVE STRENGTH (Corrected) Kg/Cm²

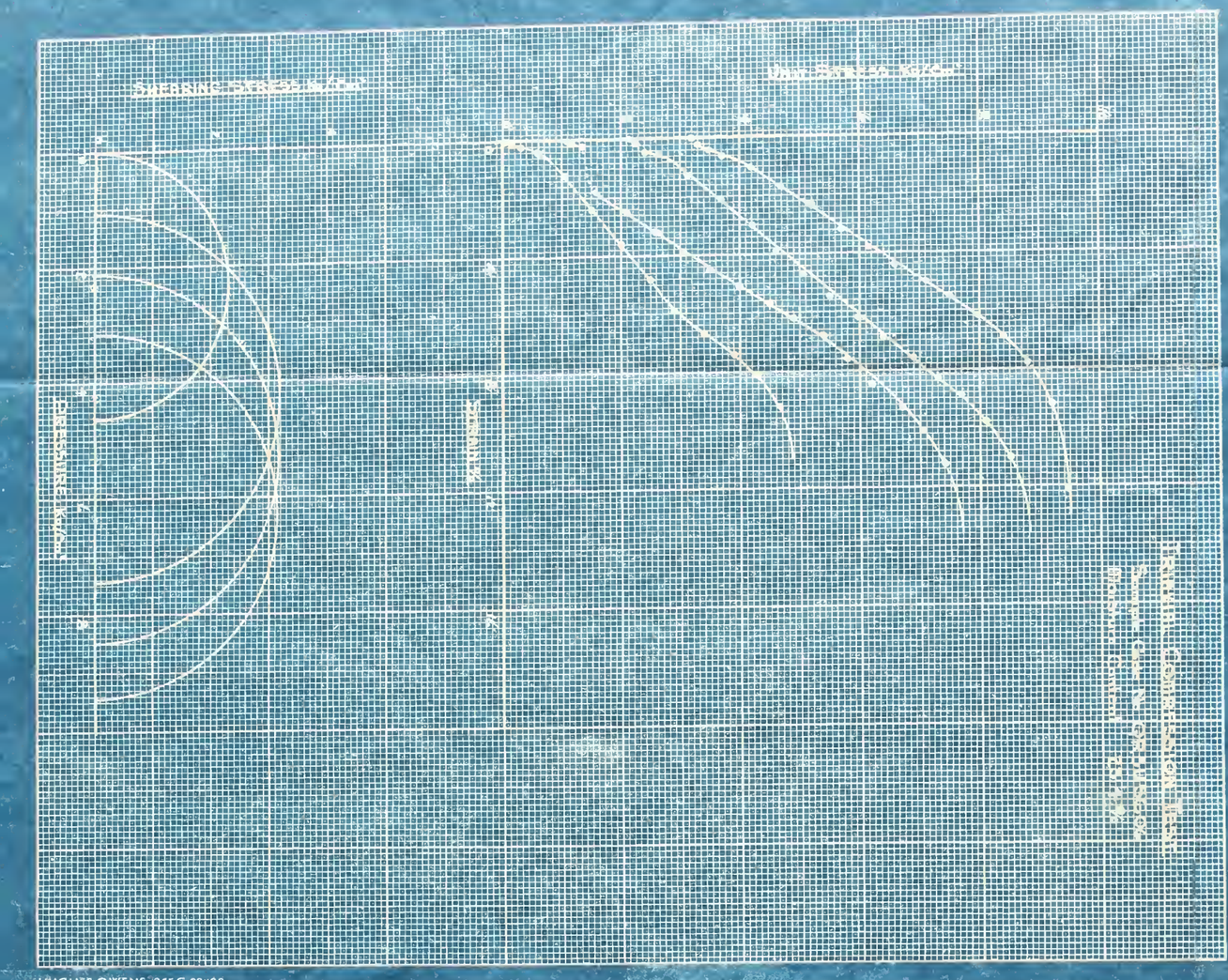


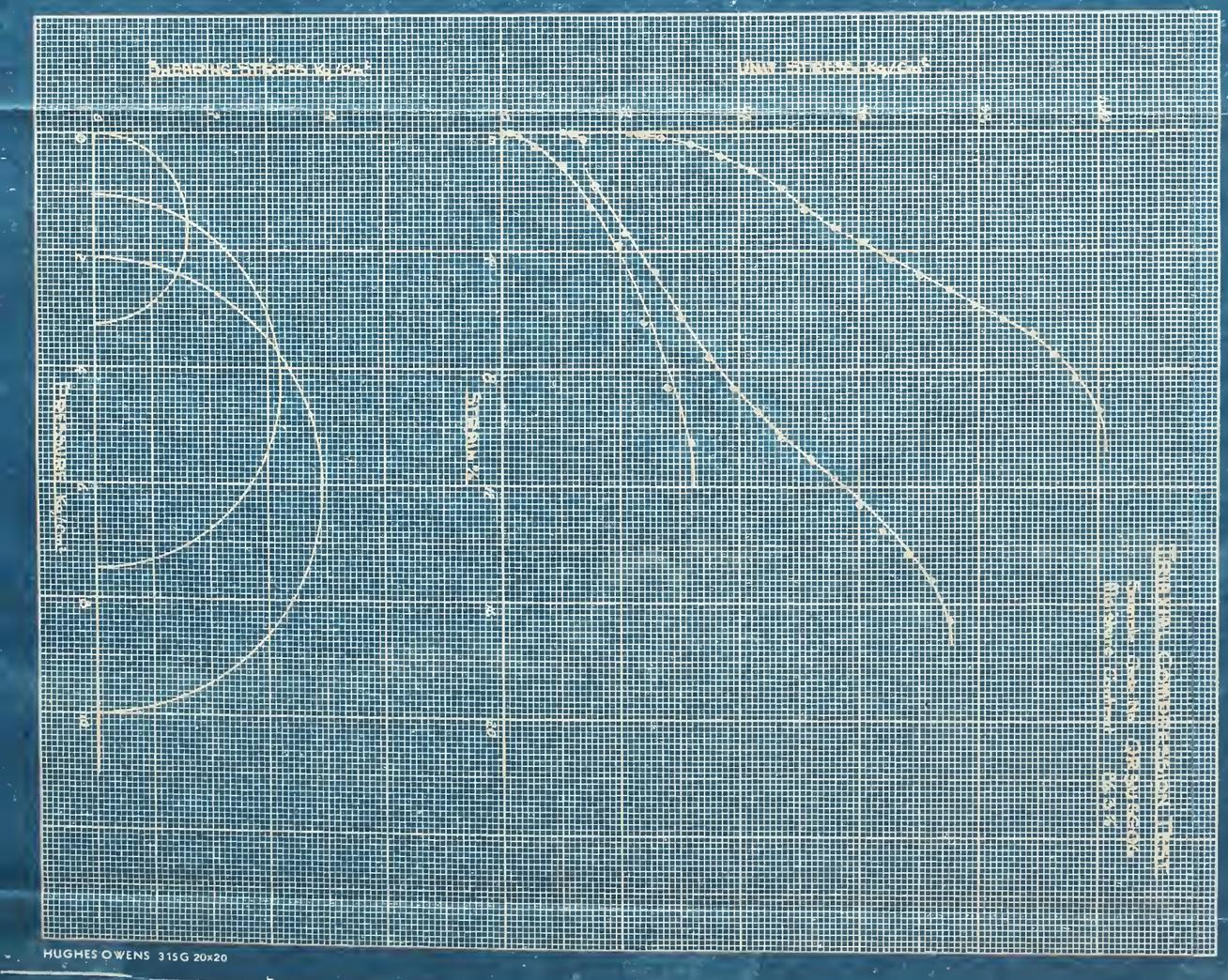
HUGHES OWENS 315C 10x10

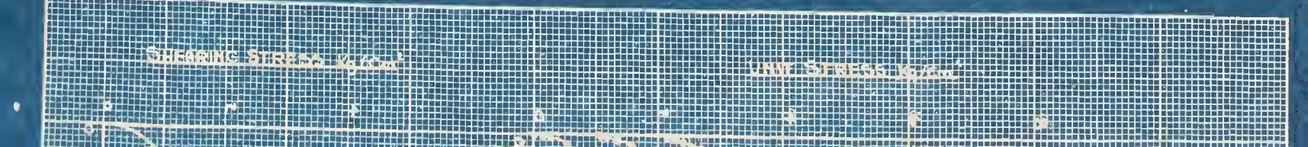


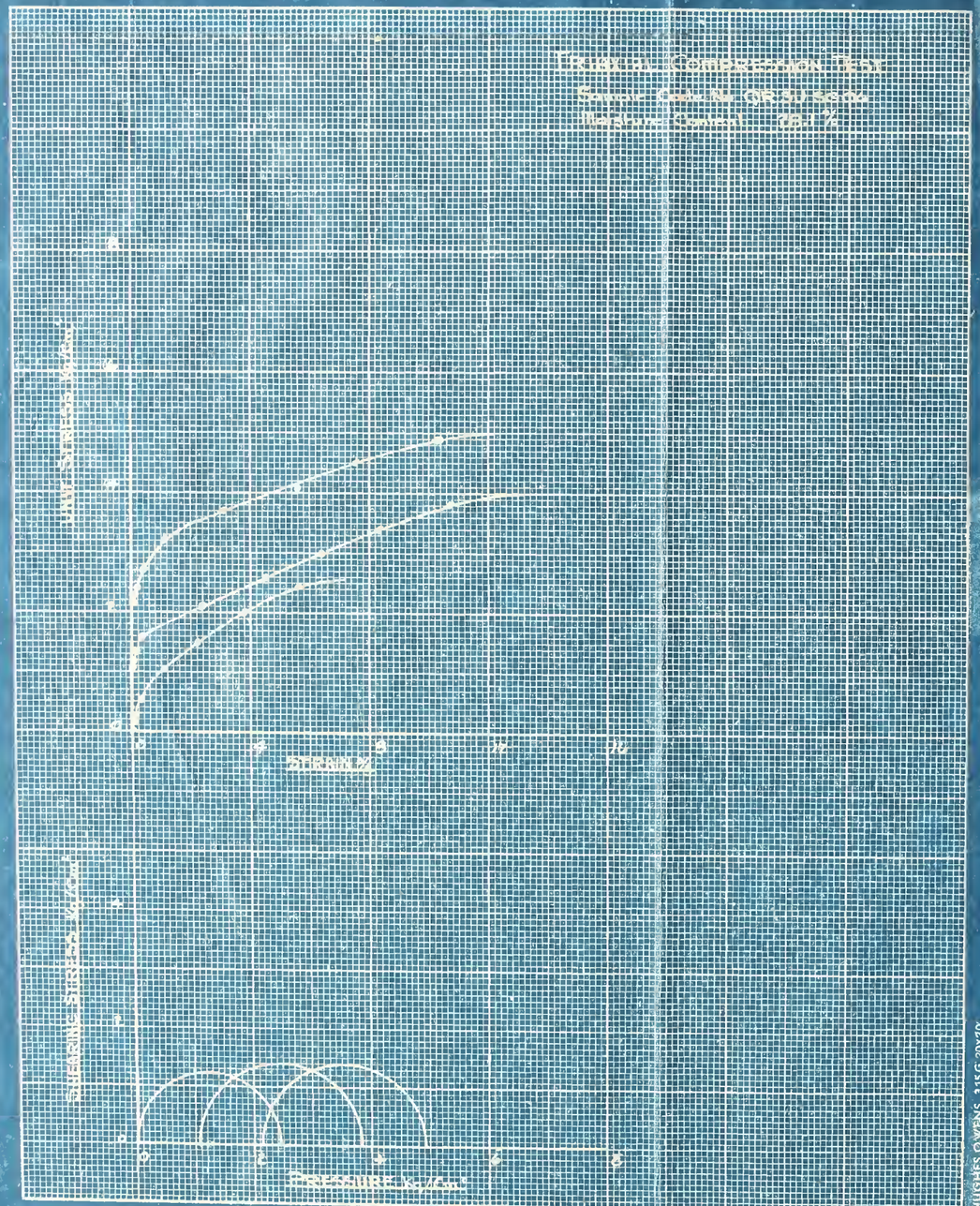
HUGHES OWENS 315G 20x20

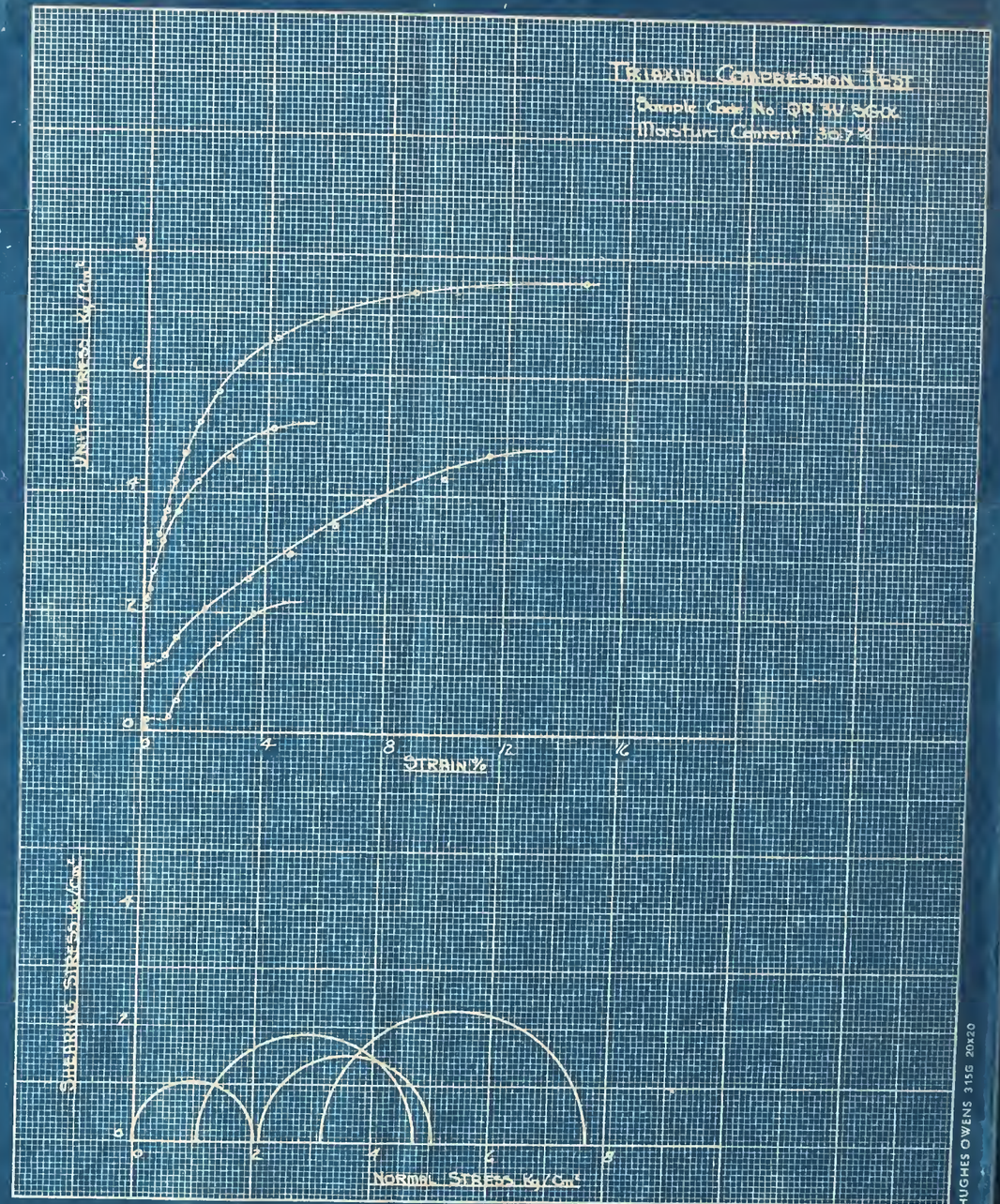

HUGHES OWENS 315G 20x20


HUGHES OWENS 315G 20x20


HUGHES OWENS 315G 20x20




Triaxial Compression Test
Sample Coal No. OR 311 Sect.
Moisture Content 3.0 %
Deviator Stress Kg/Cm²
Strain %
Shearing Stress Kg/Cm²
Normal Stress Kg/Cm²
HUGHES OWENS 315G 20X20


Triaxial Compression Test
Sample Coal No. OR 311 Sect.
Moisture Content 3.0 %
Deviator Stress Kg/Cm²
Strain %
Shearing Stress Kg/Cm²
Normal Stress Kg/Cm²
HUGHES OWENS 315G 20X20

Test

56.0%

%

HUGHES OWENS 315G 20x20

Note Subscript Scale

SHEARING STRESS Kg/Cm²

NORMAL STRESS Kg/Cm²

NORMAL STRESS Kg/Cm²

NORMAL STRESS Kg/Cm²

Triaxial Compression Test

Sample Code No. GM 30 56 α

Moisture Content 36.7%

Dry Density 81% / Cu ft - 87.2 % max

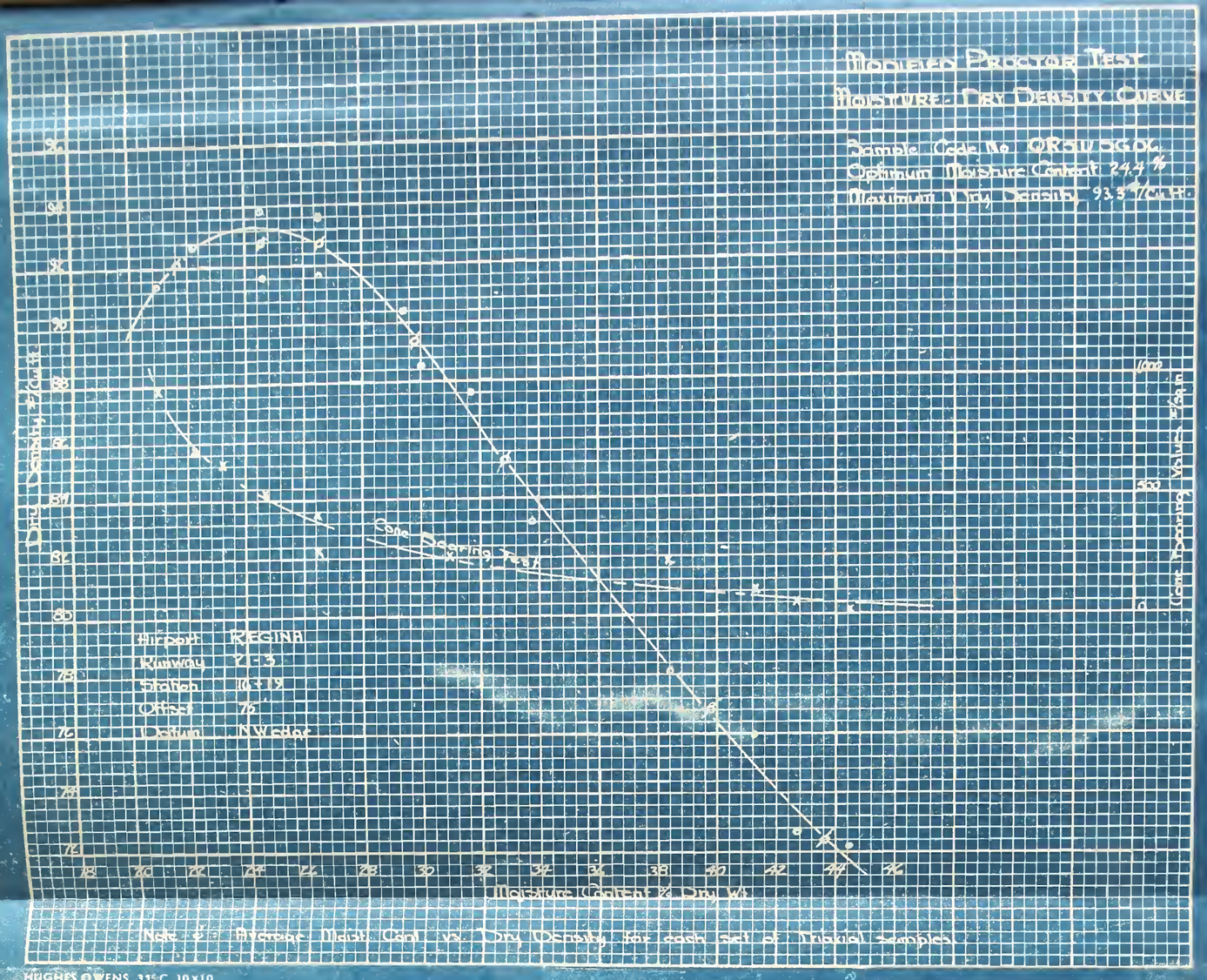
Moisture Content 41.0%

Dry Density 72.4 % / Cu ft - 82.0% max

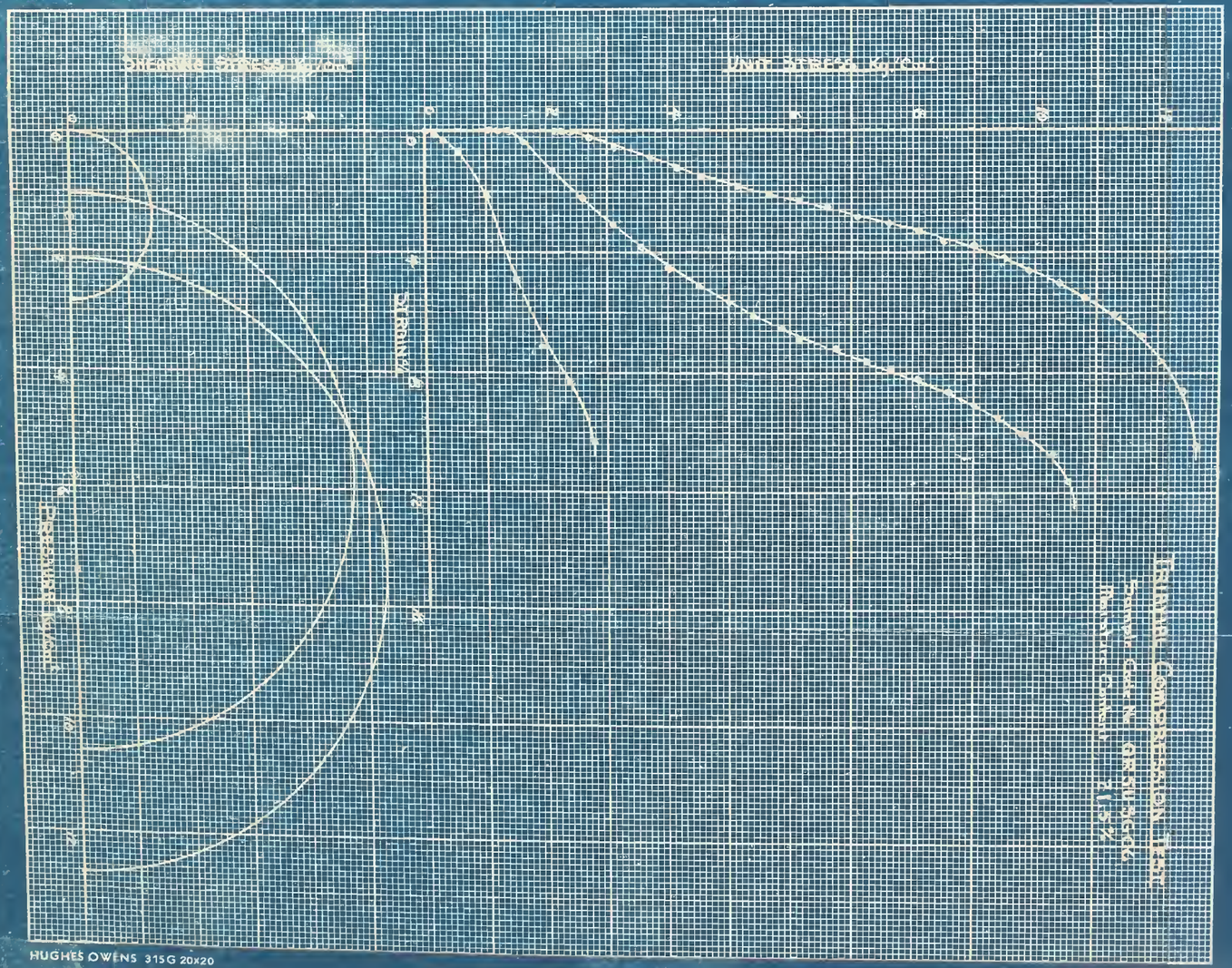
Moisture Content 57.4 %

Dry Density 45.7 % / Cu ft - 77.0% Max

HUGHES OWENS 315G 20x20

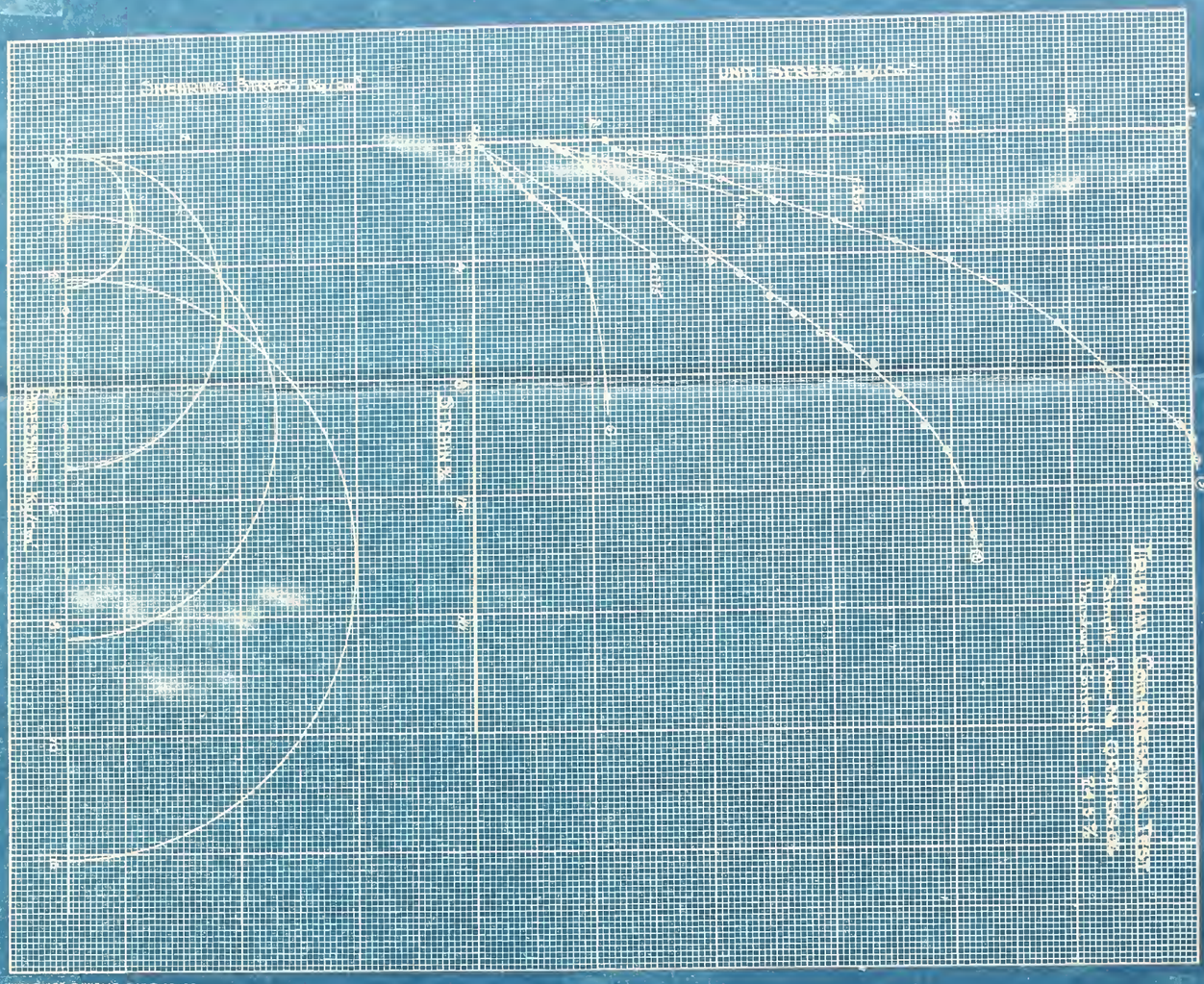

Modified Proctor Test
Moisture-Dry Density Curve
Sample Code No. ORSW-SG-06
Optimum Moisture Content 24.4 %
Maximum Dry Density 93.5 #/cu.ft.
Dry Density #/cu.ft.
Moisture Content % Dry wt.
Airport REGINA
Runway 12-30
Station 10+12
Offset 76
Datum N.W. Bar
Note: * = Highway Proctor Curve vs. Dry Density for each set of Natural Samples

HUGHES OWENS 315C 10X10

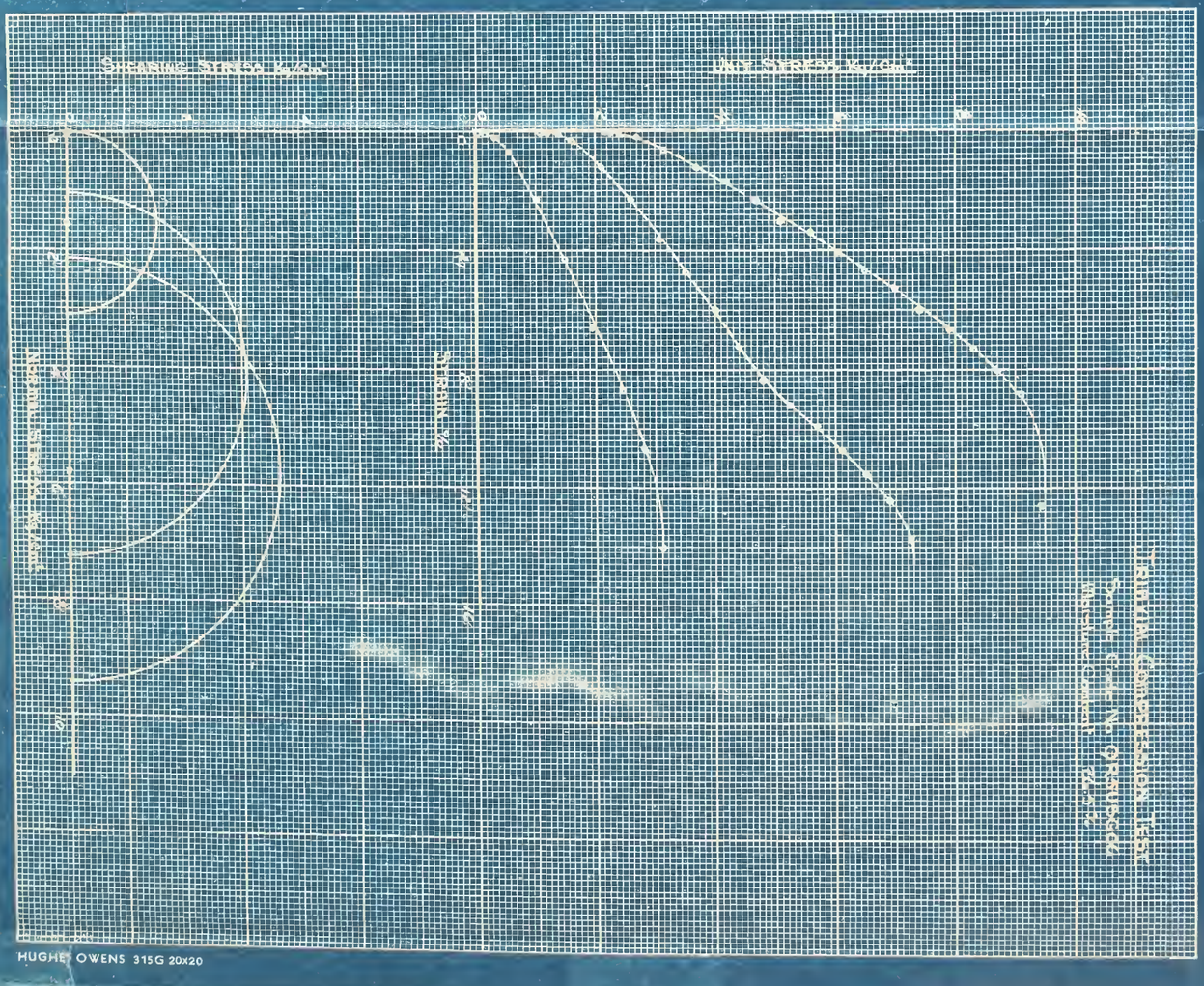


HUGHES OWENS 315G 20X20

HUGHES OWENS 315G 20x20

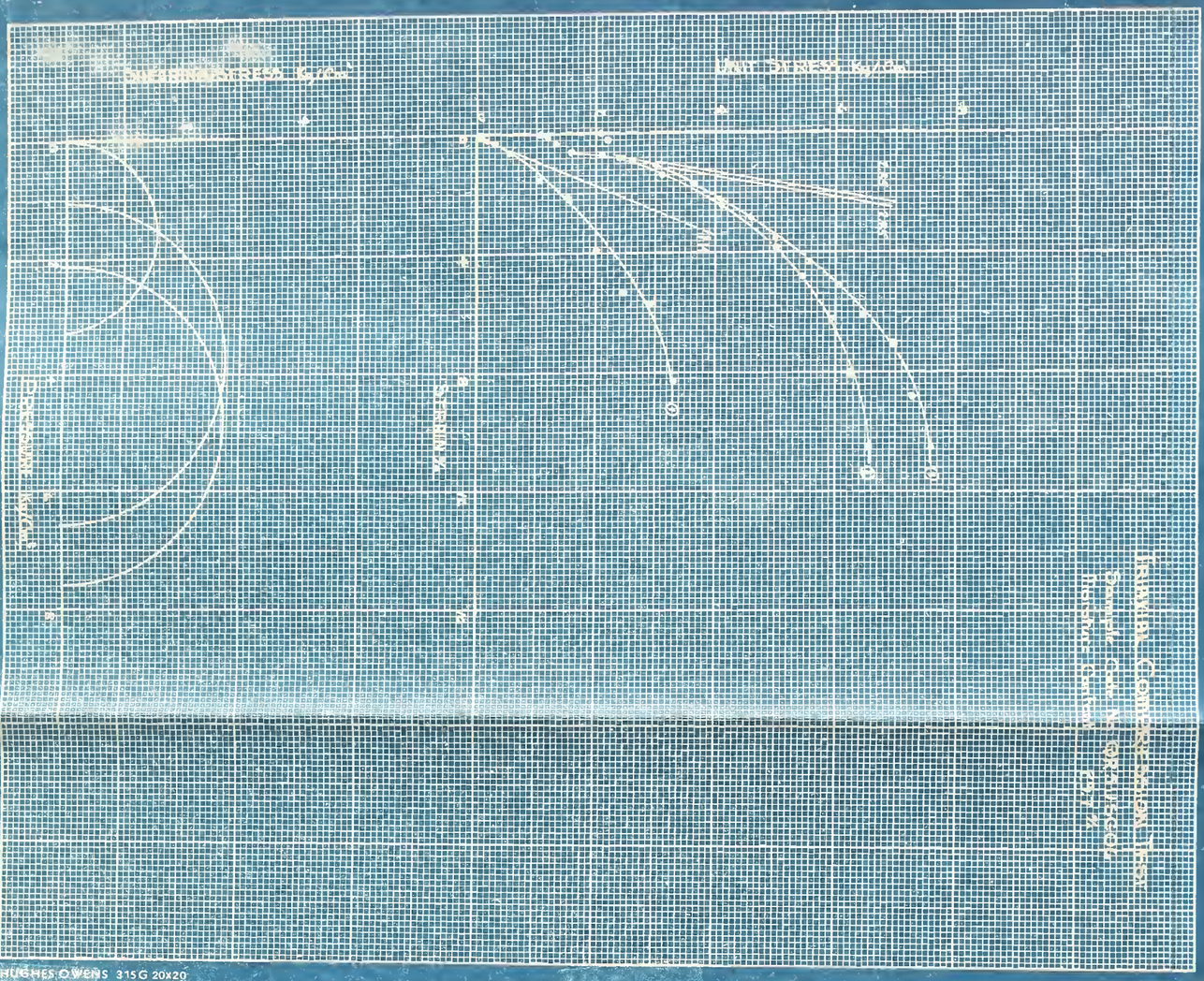


HUGHES OWENS 315G 20x20



HUGHES OWENS 315G 20x20

HUGHES OWENS 315G 20x20

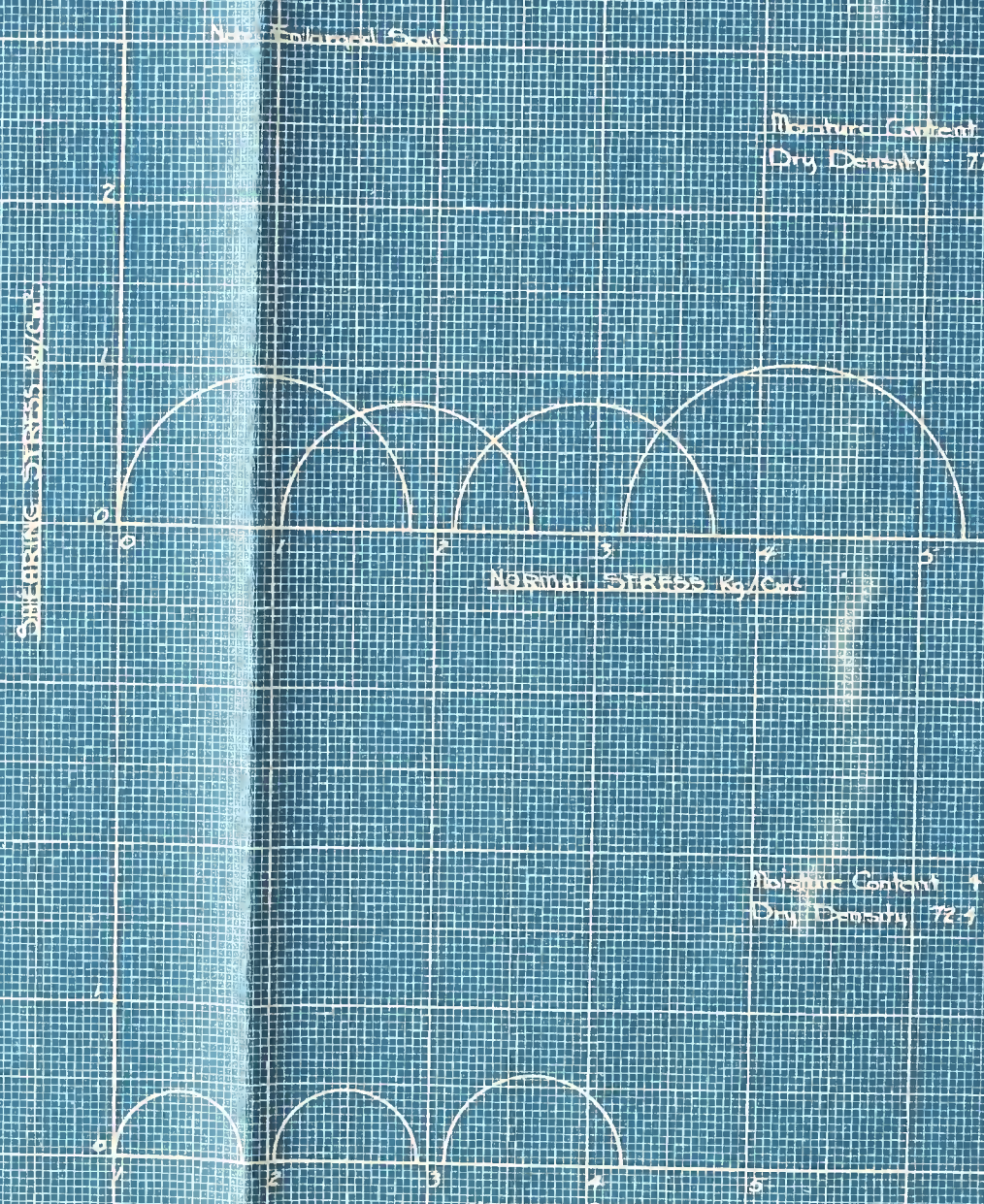


HUGHES OWENS 315G 20x20

HUGHES OWENS 315G 20x20

Triaxial Compression Test

Sample Code No. GR5U'5G04



Moisture Content 39.8%
Dry Density 77.0 #/Cu.ft. = 87.4% max

Moisture Content 43.6%
Dry Density 72.4 #/Cu.ft = 77.8% Max

HUGHES OWENS 315G 20x20

Modified Proctor Test

Moisture-Dry Density Curve

Sample Code No. QR/US502
Optimum Moisture Cont. 22 1/2%
Maximum Dry Density 92 1/2 Pcf

Dry Density Pcf

Moisture Content % Dry Wt.

Airport: Regina
Runway: 12-30
Station: 29+000
Offset: 7S
Datum: N.W. Edge

Note 9 = Average Moist Cont. vs Dry Density for Each Set of Triaxial Samples

HUGHES OWENS 315C 10X10

Triaxial Compression Test

Sample Code No. QR/US502
Moisture Content 17.9%

Shearing Stress Kg/Cm²

Normal Stress Kg/Cm²

Unit Strain %

Unit Stress Kg/Cm²

Unit Reduced Scale

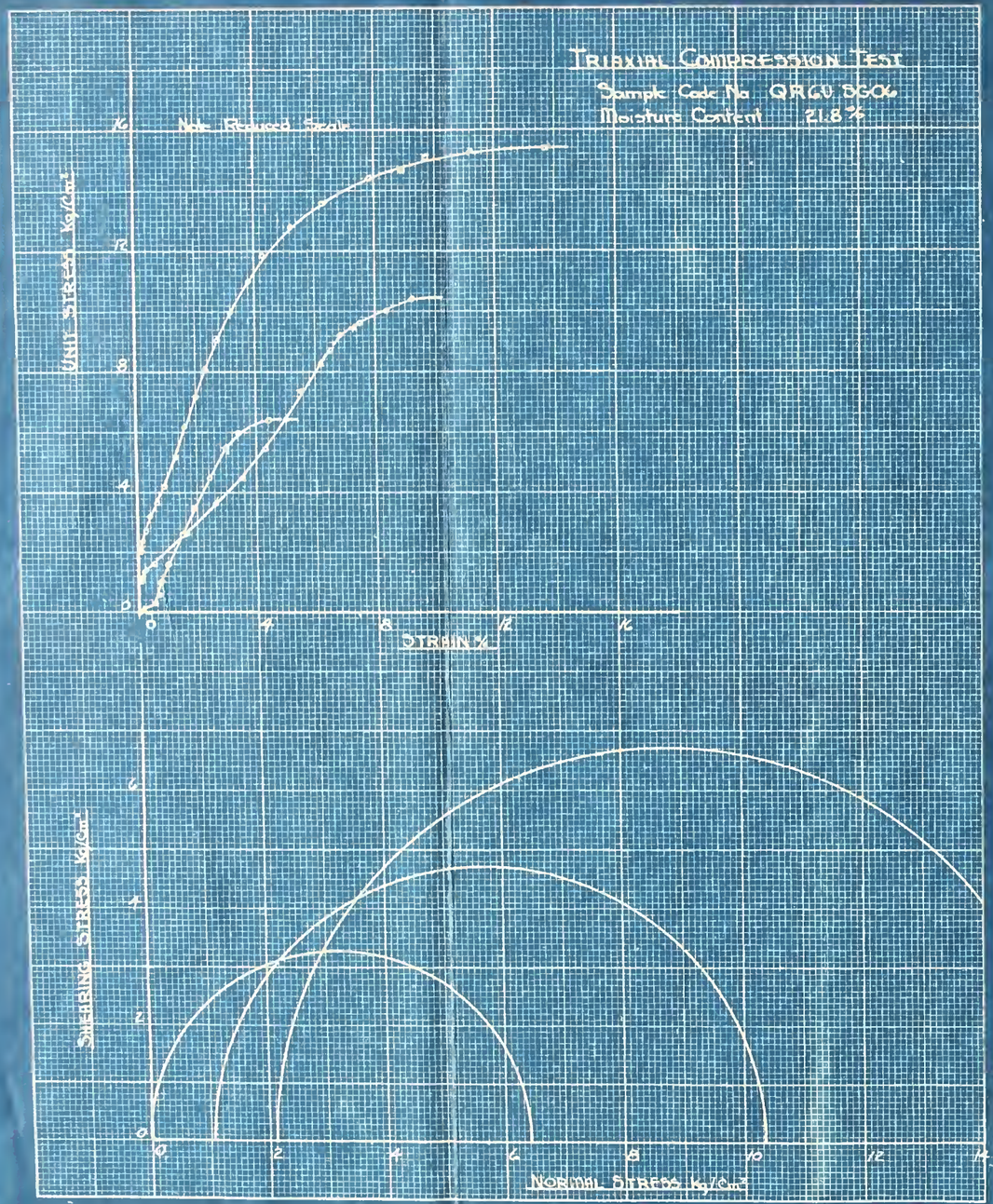
HUGHES OWENS 315G 20X20

Shearing Stress Kg/Cm²

Unit Stress Kg/Cm²

Triaxial Compression Test

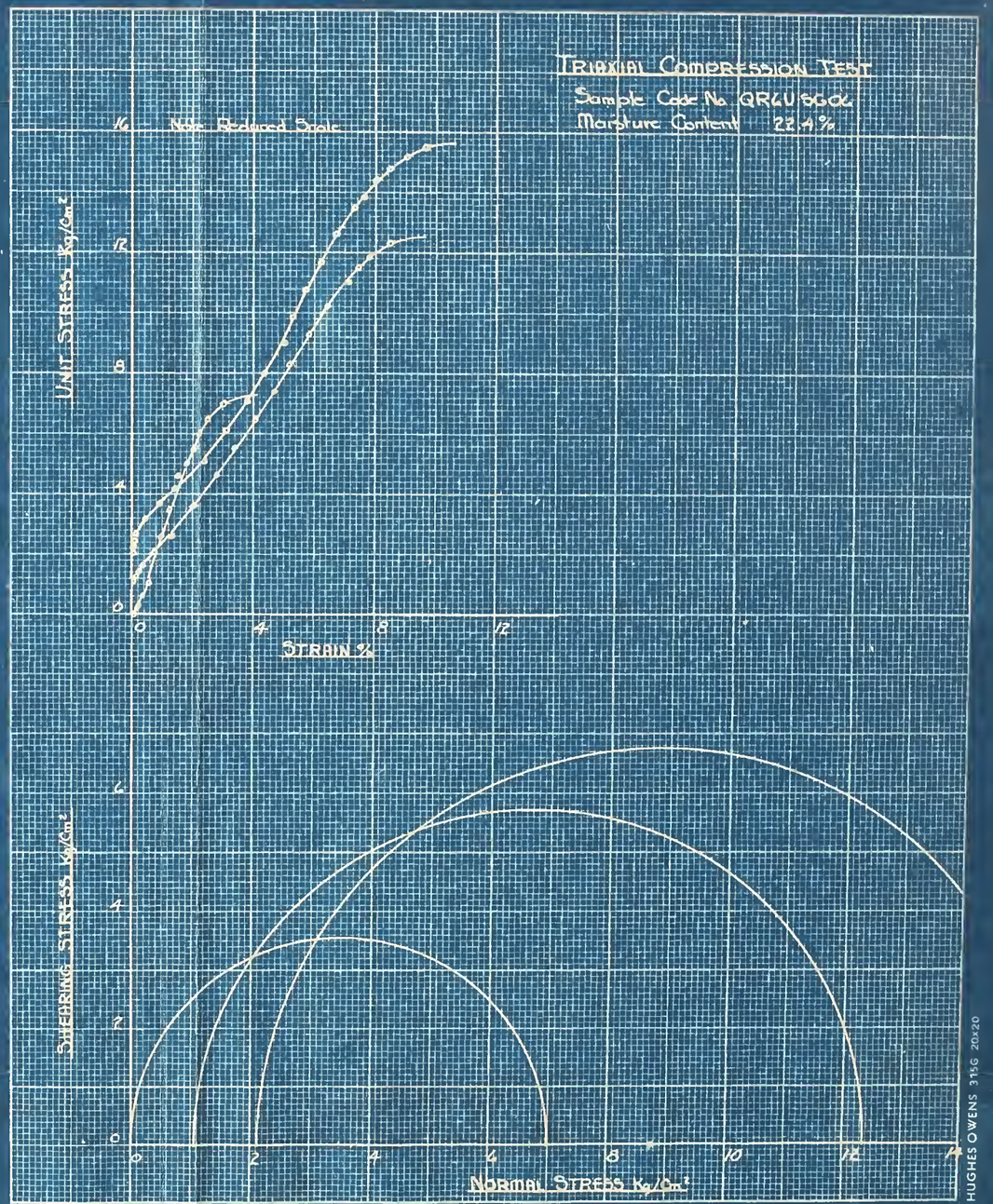
Sample Code No. QR4U 5604
Moisture Content 21.8 %



HUGHES OWENS 315G 20x20

Triaxial Compression Test

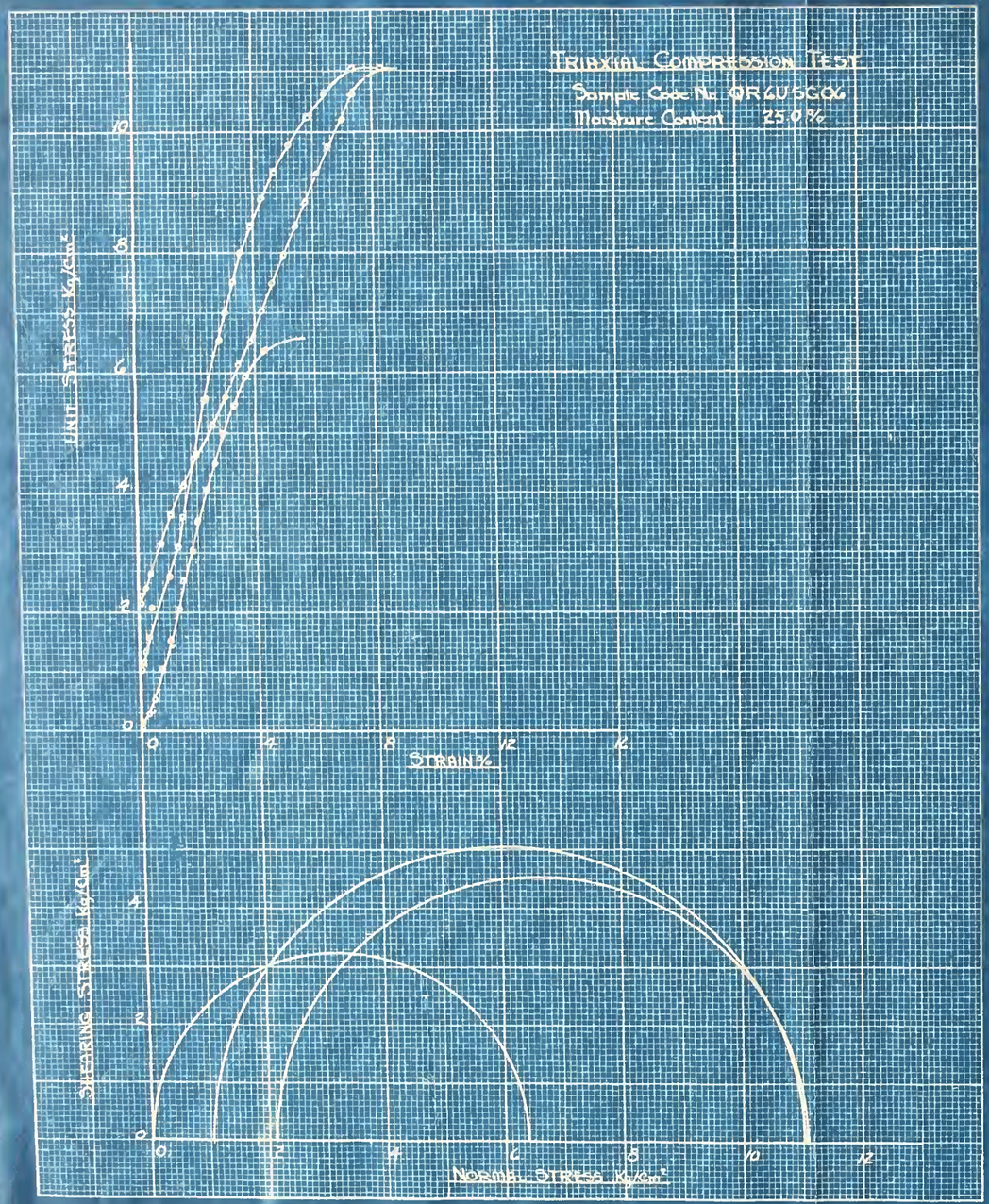
Sample Code No. QR4U 5604
Moisture Content 22.4 %



HUGHES OWENS 315G 20x20

Triaxial Compression Test

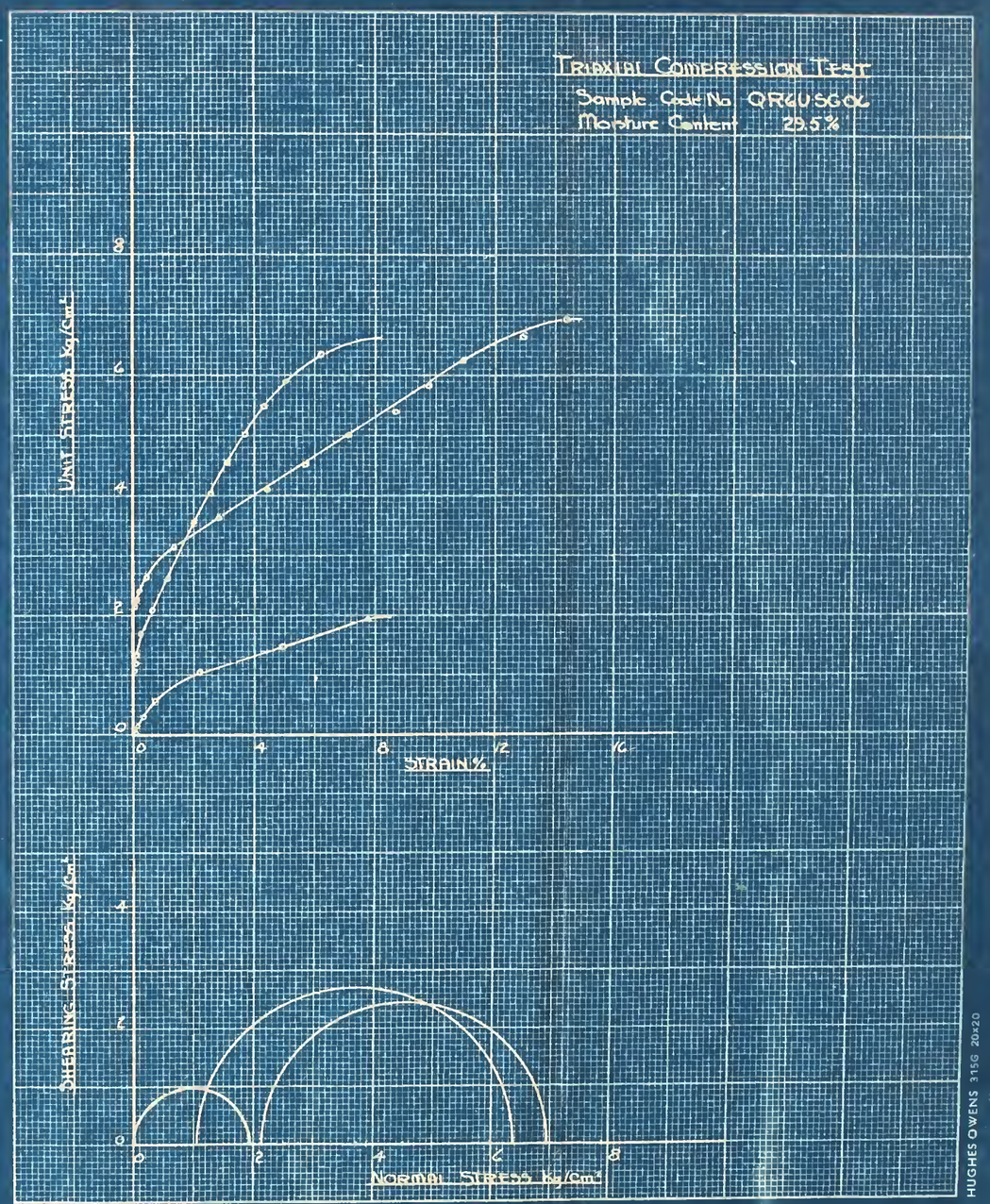
Sample Code No. QR4U5G0C
Moisture Content 25.0%



HUGHES OWENS 315G 20x20

Triaxial Compression Test

Sample Code No. QR4U5G0L
Moisture Content 29.5%



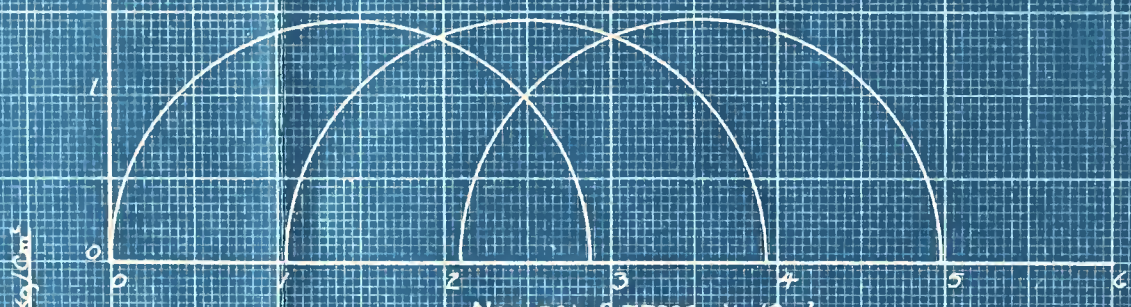
HUGHES OWENS 315G 20x20

Triaxial Compression Test

Sample Code No QR6US606

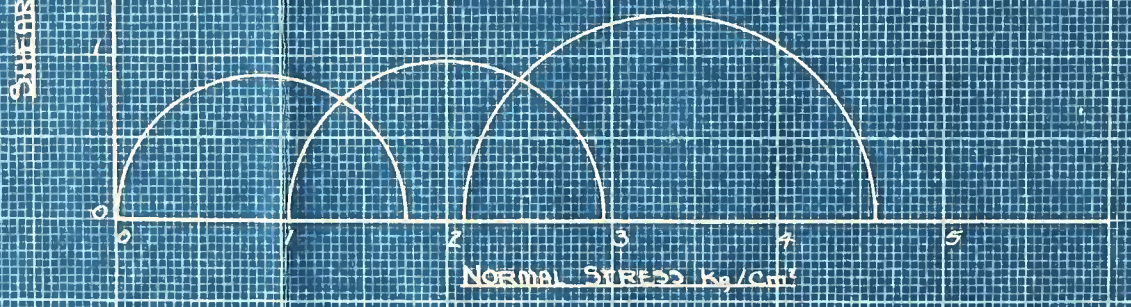
Note Enlarged Scale

Moisture Content 33.8%
Dry Density 85.6 #/Cu ft. : 93.2% Max.

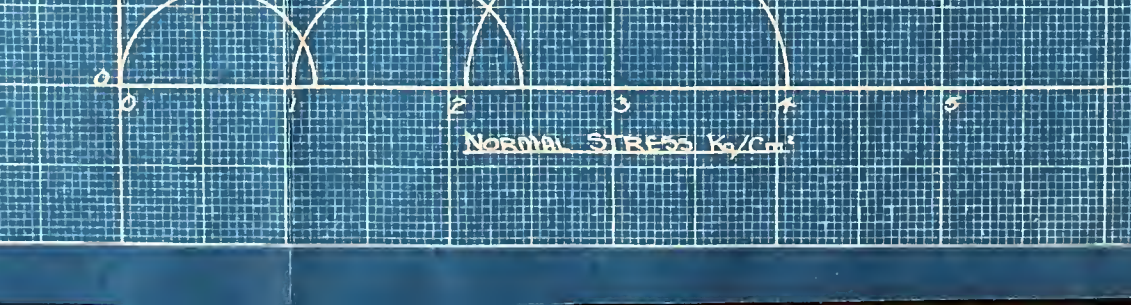


Shearing Stress Kg/Cm²

Moisture Content 34.8%
Dry Density 76.5 #/Cu ft. : 82.2% max.

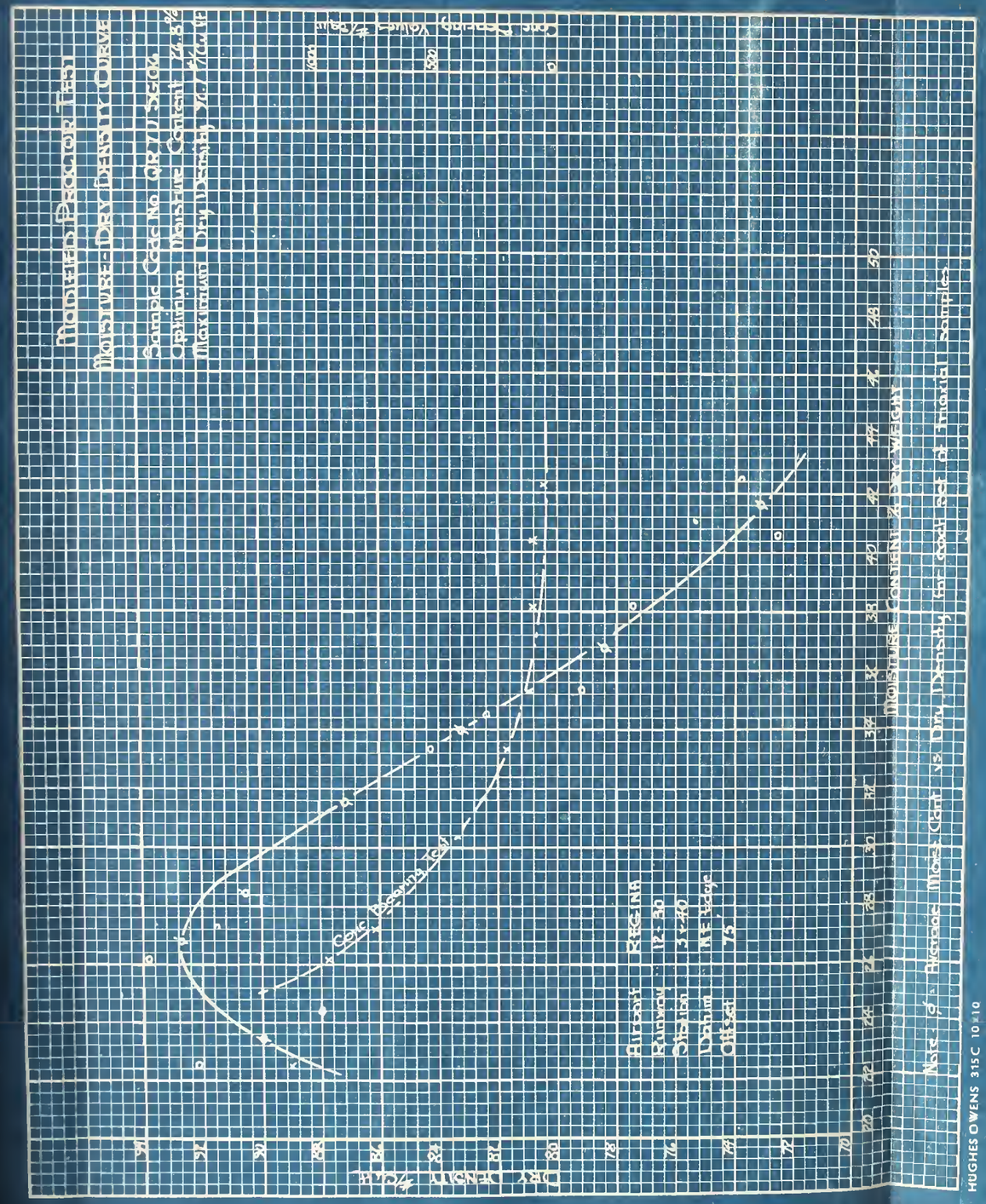


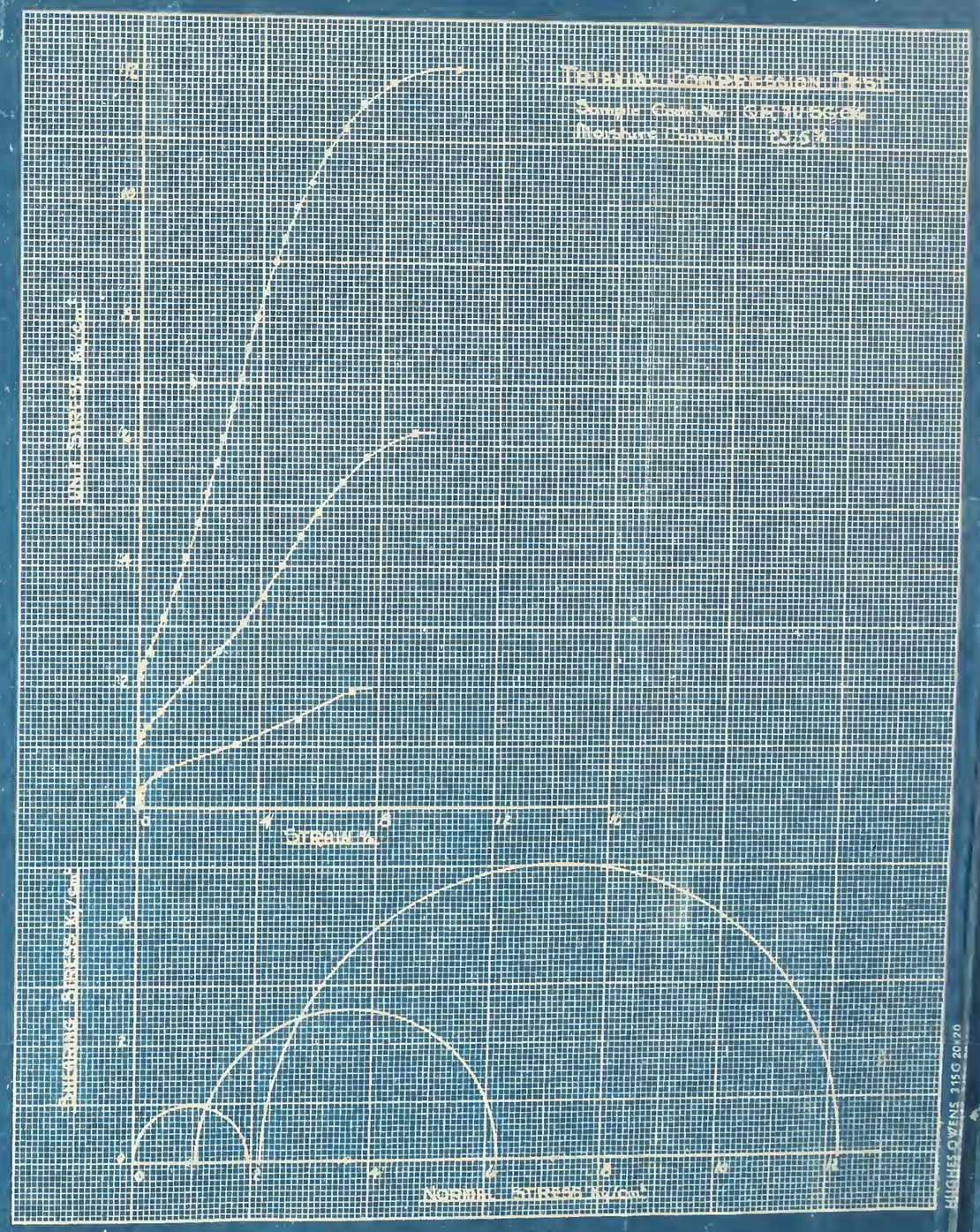
Moisture Content 37.9%
Dry Density 72.3 #/Cu ft. : 78.7% max.



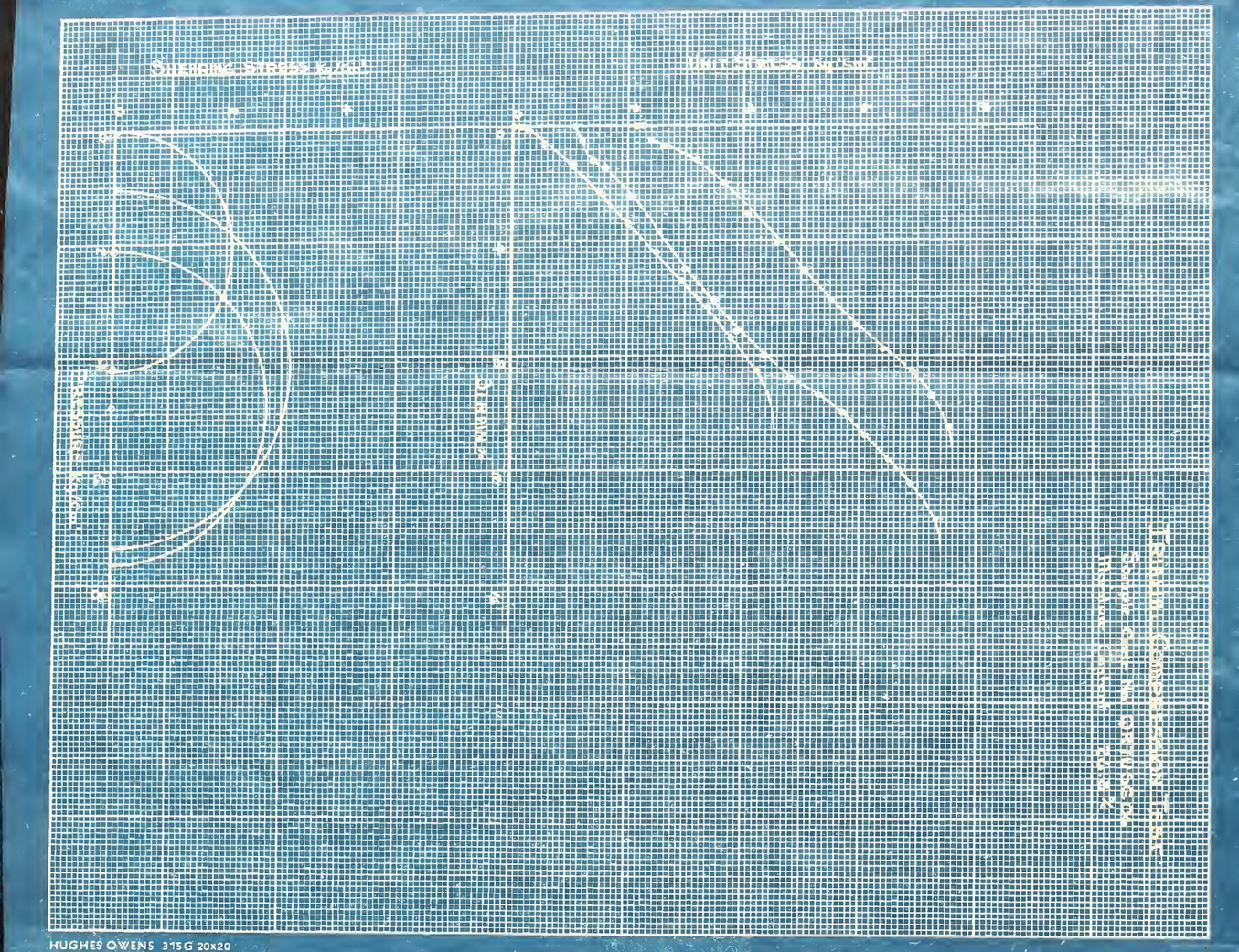
HUGHES OWENS 315G 20x20

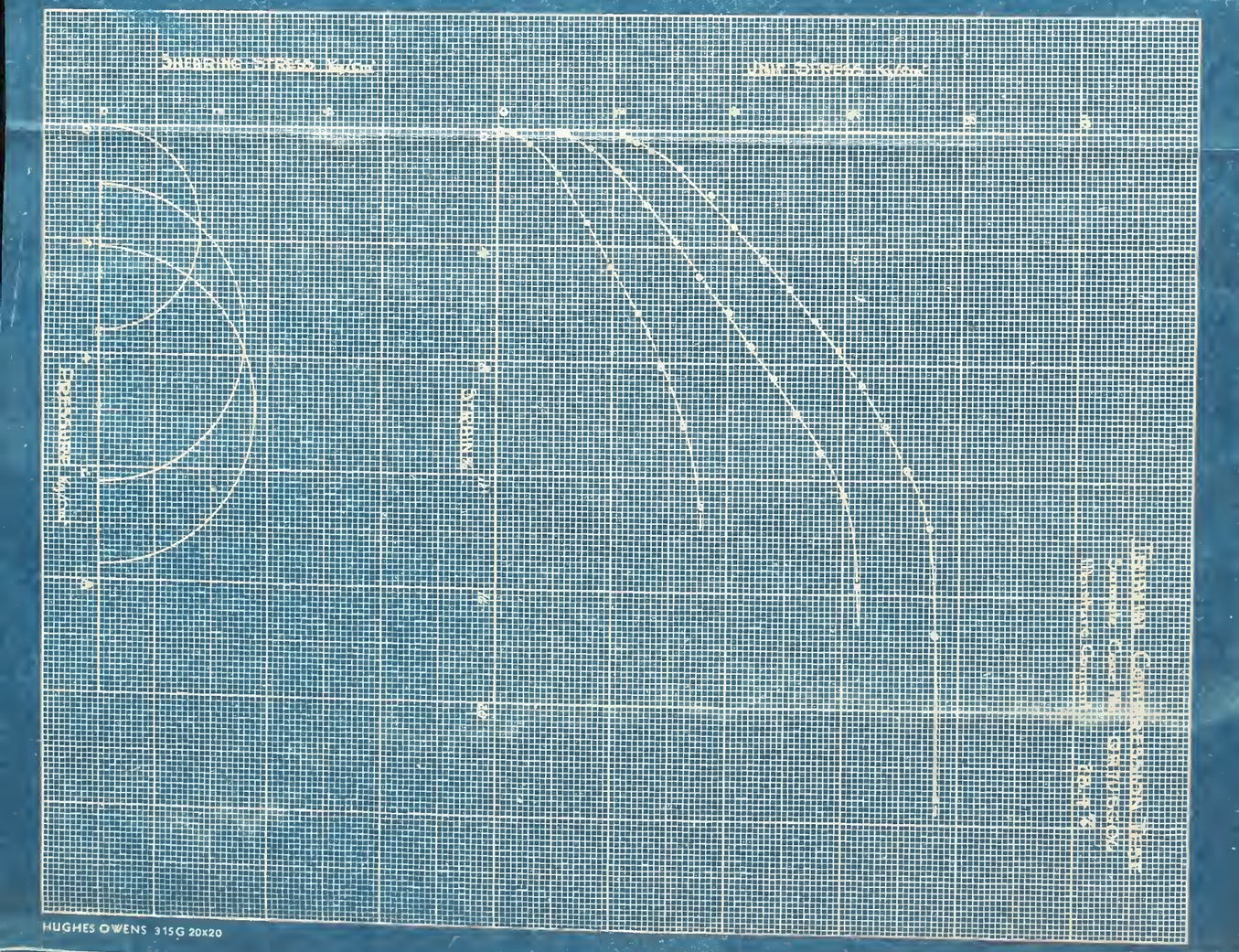
HUGHES OWENS 315G 20x20

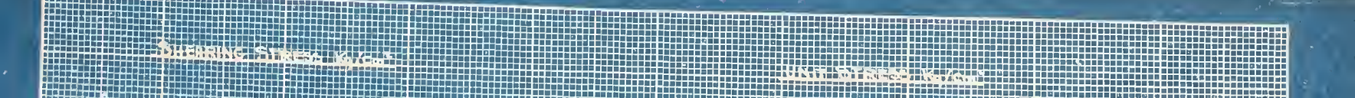

Modified Proctor Test
Moisture-Dry Density Curve
Sample Code No. 0827-P-5602
Location Destruction Gravel
Material Dry Density
Core Sample Values
Dry Density, lbs/cu ft
Moisture Content, % of Dry Weight
Note: If Percent Moisture Content is Dry Density, Use Scale
Aircraft
Runway
Taxiway
Apron
Percent
12 - 30
1 - 2 (30)
NT - Tester
15
HUGHES OWENS 315C 10-10


Triaxial Compression Test
Sample Code No. 0827-P-5602
Material Destruction Gravel
Dry Density, lbs/cu ft
Moisture Content, % of Dry Weight
Shearing Stress, lbs/sq in
Normal Stress, lbs/sq in
HUGHES OWENS 315G 20-20

HUGHES OWENS 315G 20x20


HUGHES OWENS 315G 20x20


HUGHES OWENS 315G 20x20



HUGHES OWENS 315G 20x20

Torsion Compression Test

Steel Tube No. OR 1025-T6
Nominal Carbon 0.25 %

Steering Stress kg/cm²

Steering Stress kg/cm²

Deflection kg/cm²

HUGHES OWENS 315G 20x20

Torsion Compression Test

Nominal Carbon 0.25 %

Steering Stress kg/cm²

Steering Stress kg/cm²

Deflection kg/cm²

HUGHES OWENS 315G 20x20

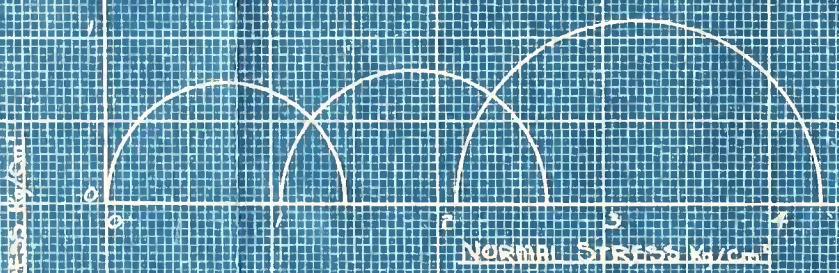
Steering Stress kg/cm²

Triaxial Compression Test

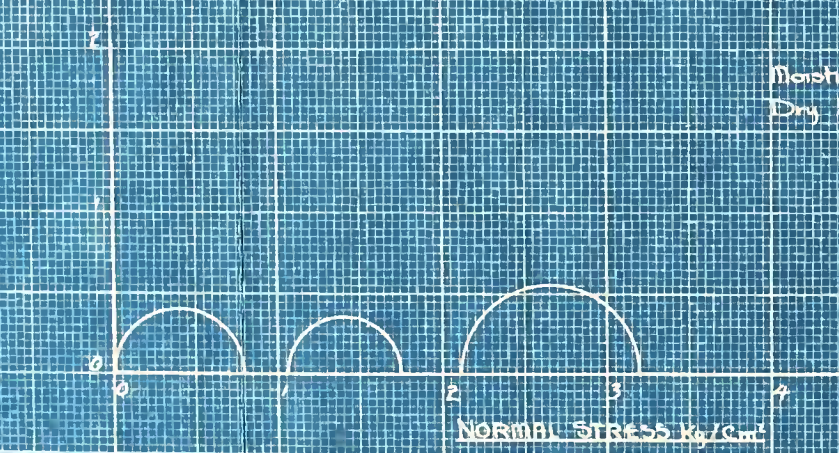
Sample Case No 9R70SG04

Note Enlarged Scale

Moisture Content 37.1%
Dry Density 78.2 #/Cu.ft = 89.4% Max

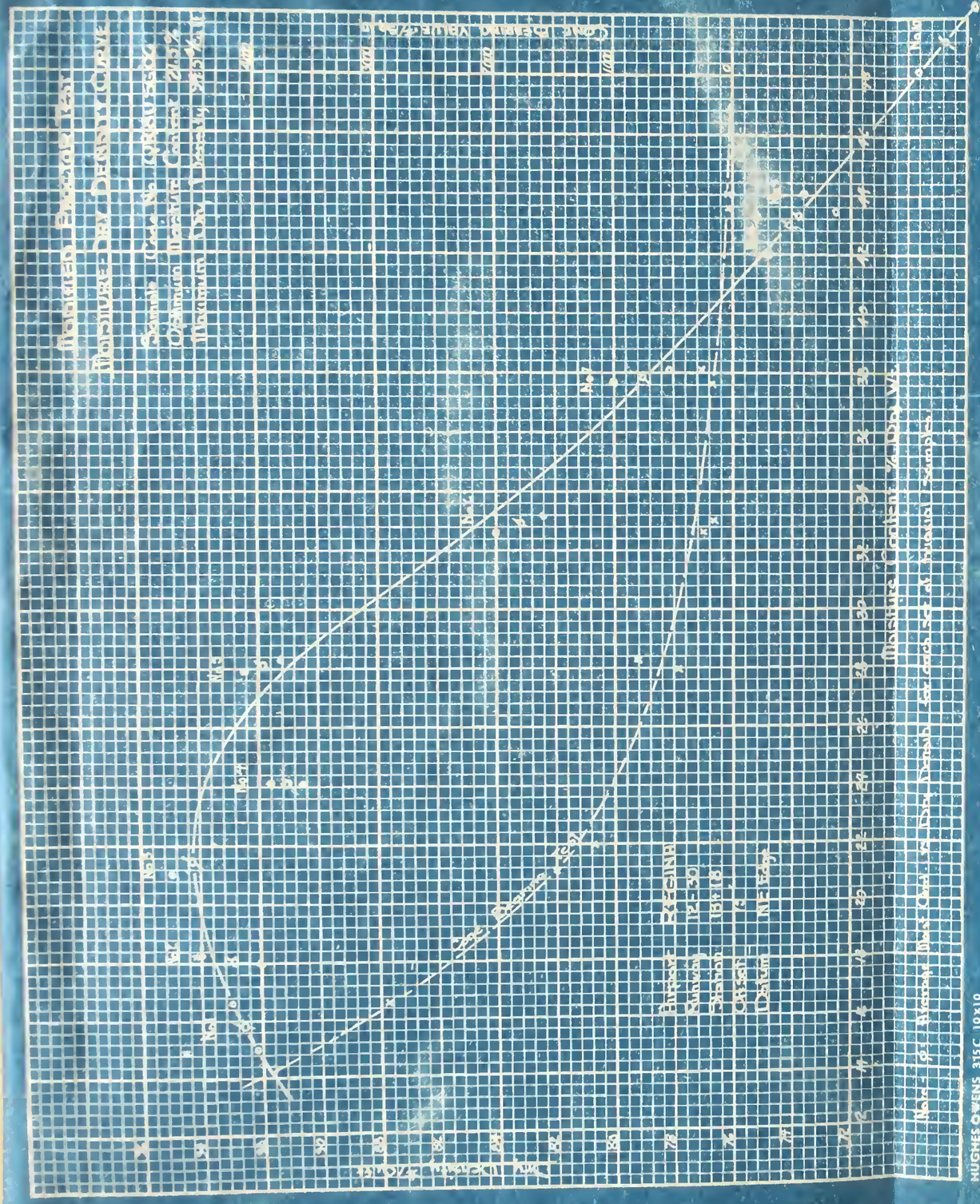


Moisture Content 41.5%
Dry Density 78.2 #/Cu.ft = 75.0% Max

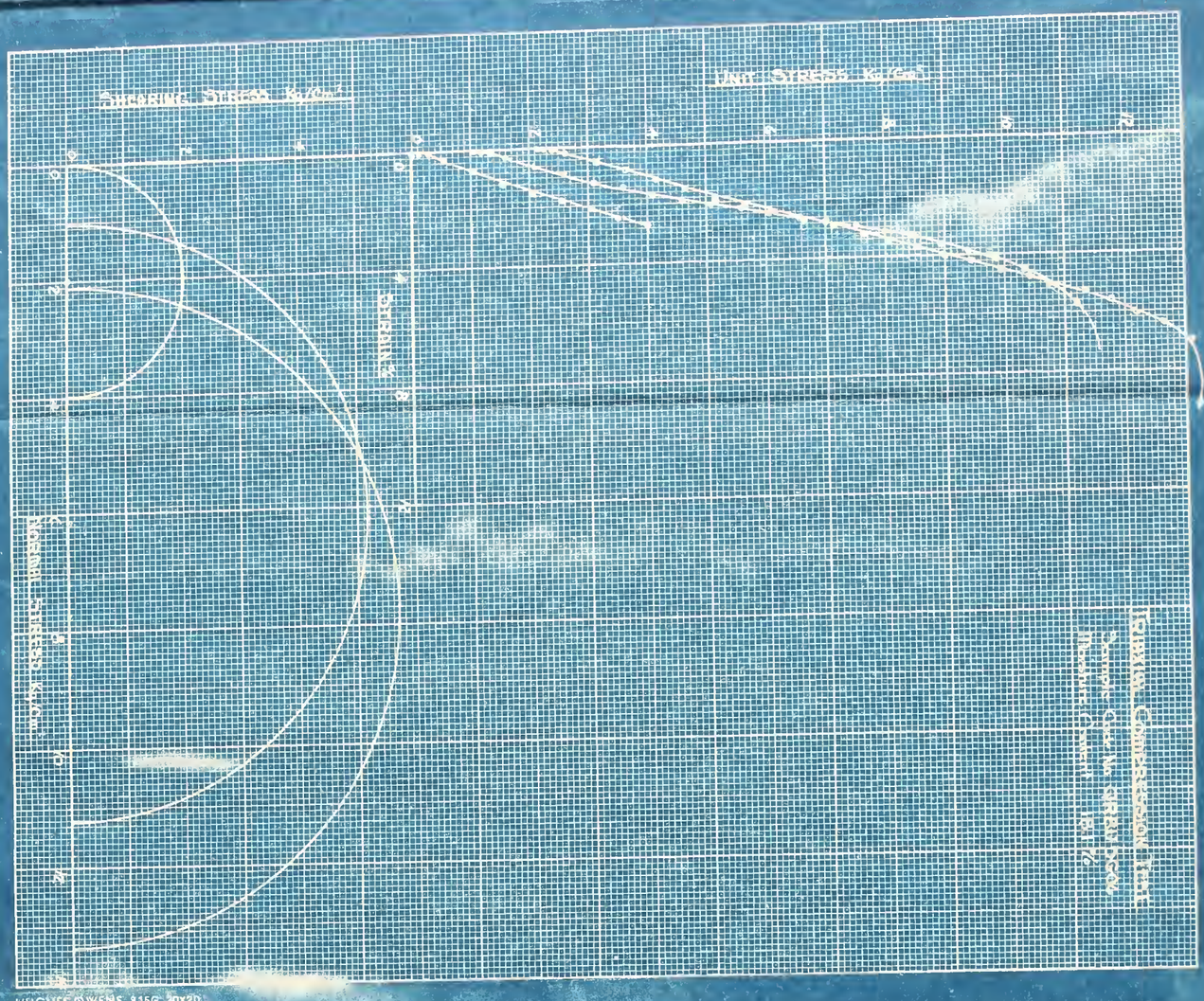


HUGHES OWENS 315G 20x20

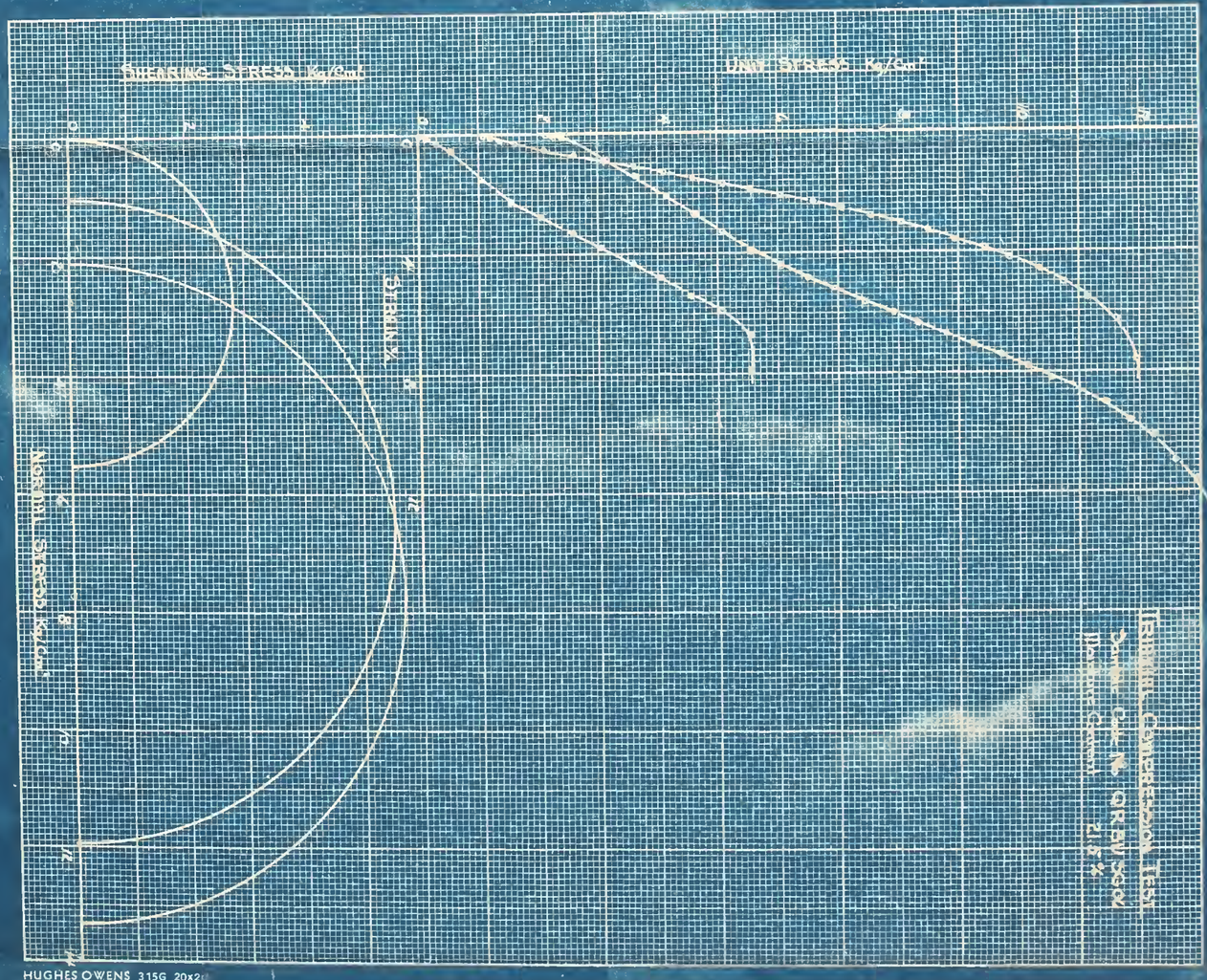
HUGHES OWENS 315G 20x20


Boussinesq Theory
Burmister Theory
Odeen Method
Datum
Mean Pressure Bulb Curve
Mean Pressure Bulb Curve
Mean Pressure Bulb Curve

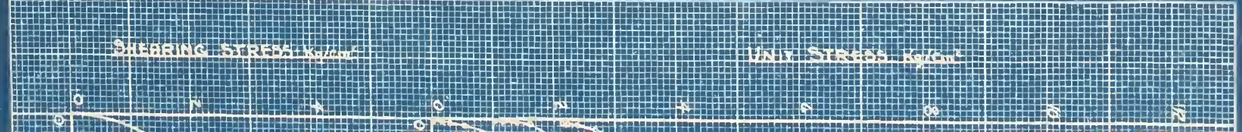
HUGHES OWENS 315G 20x20



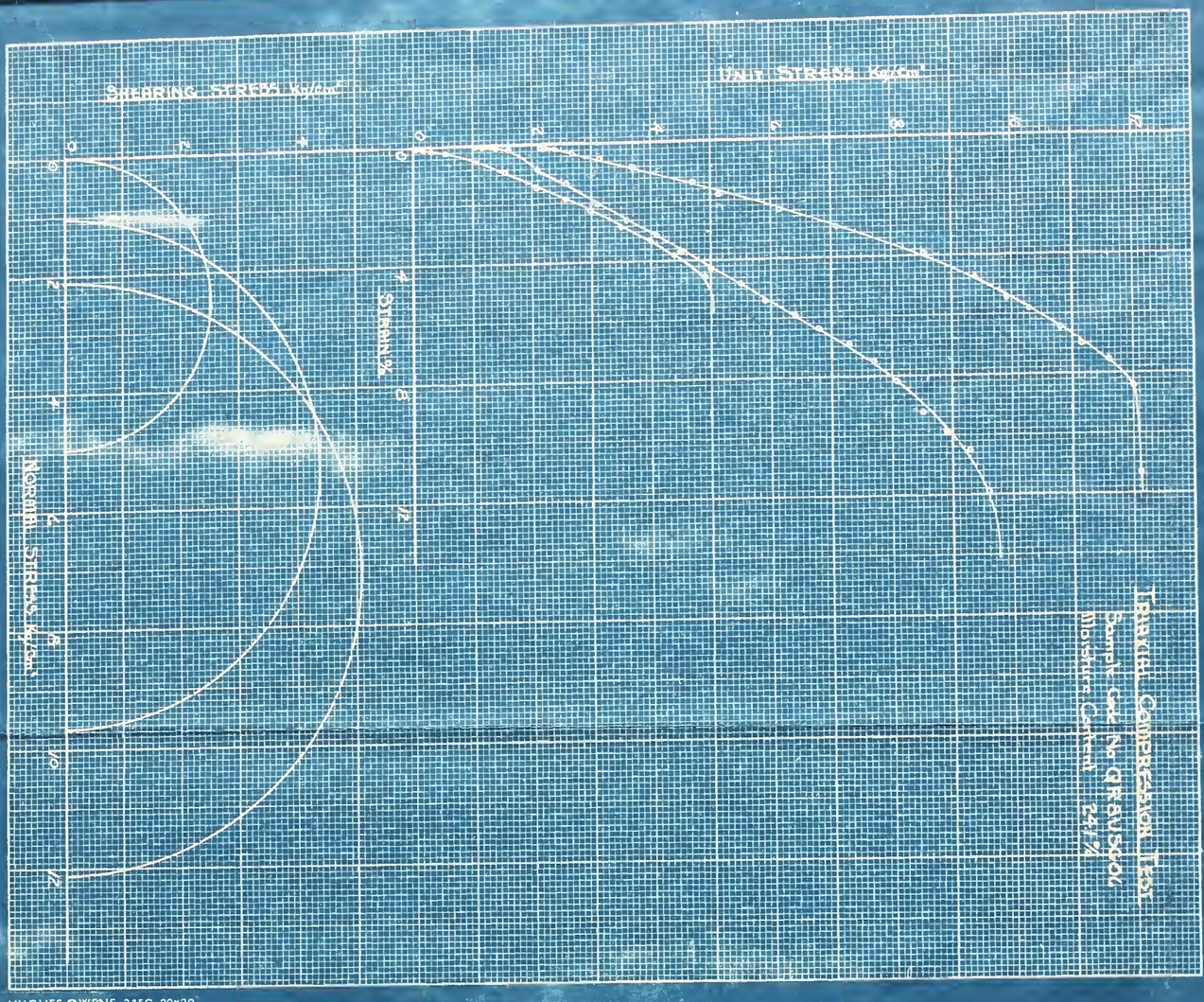
HUGHES OWENS 315G 20x20



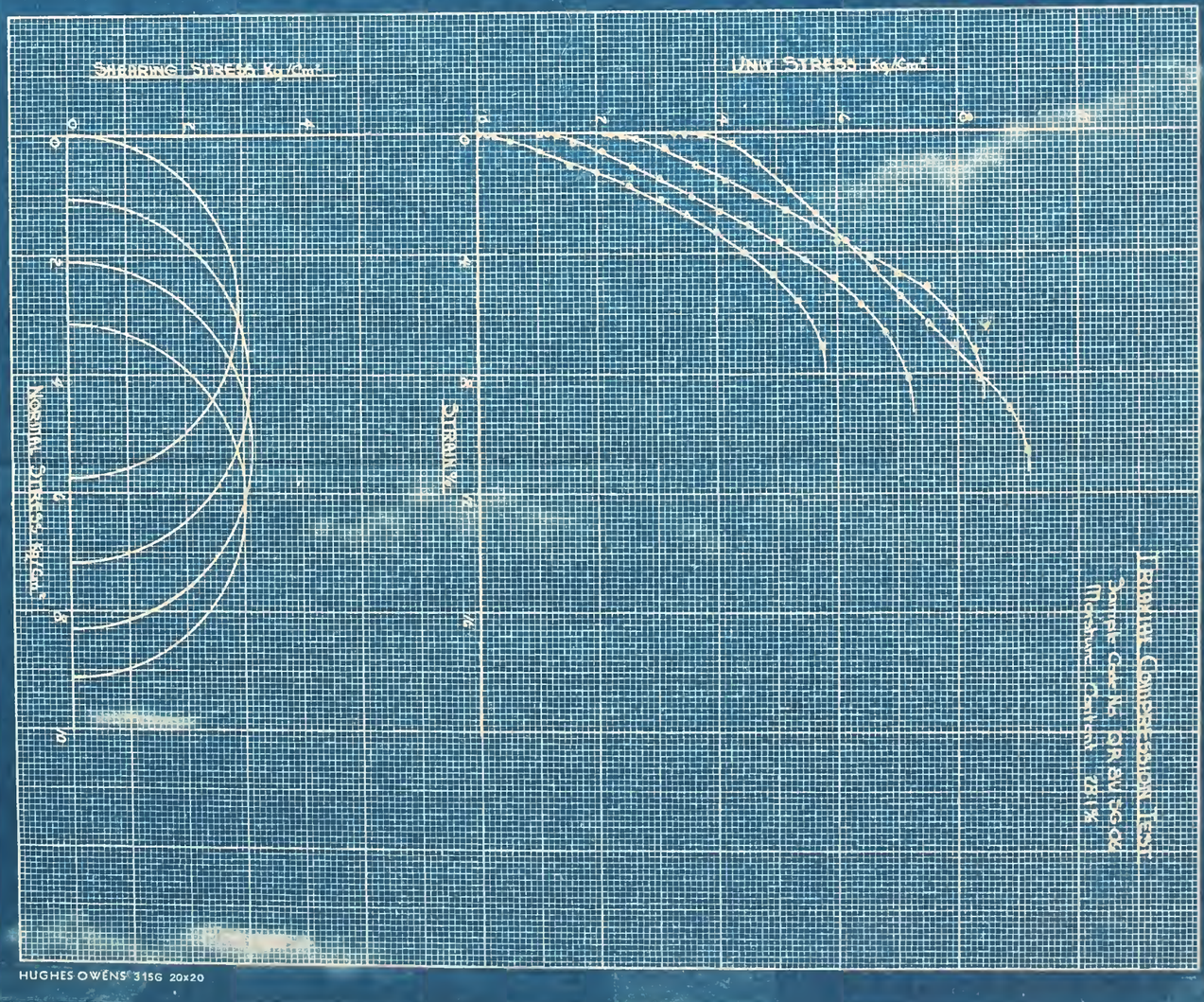
HUGHES OWENS 315G 20x2



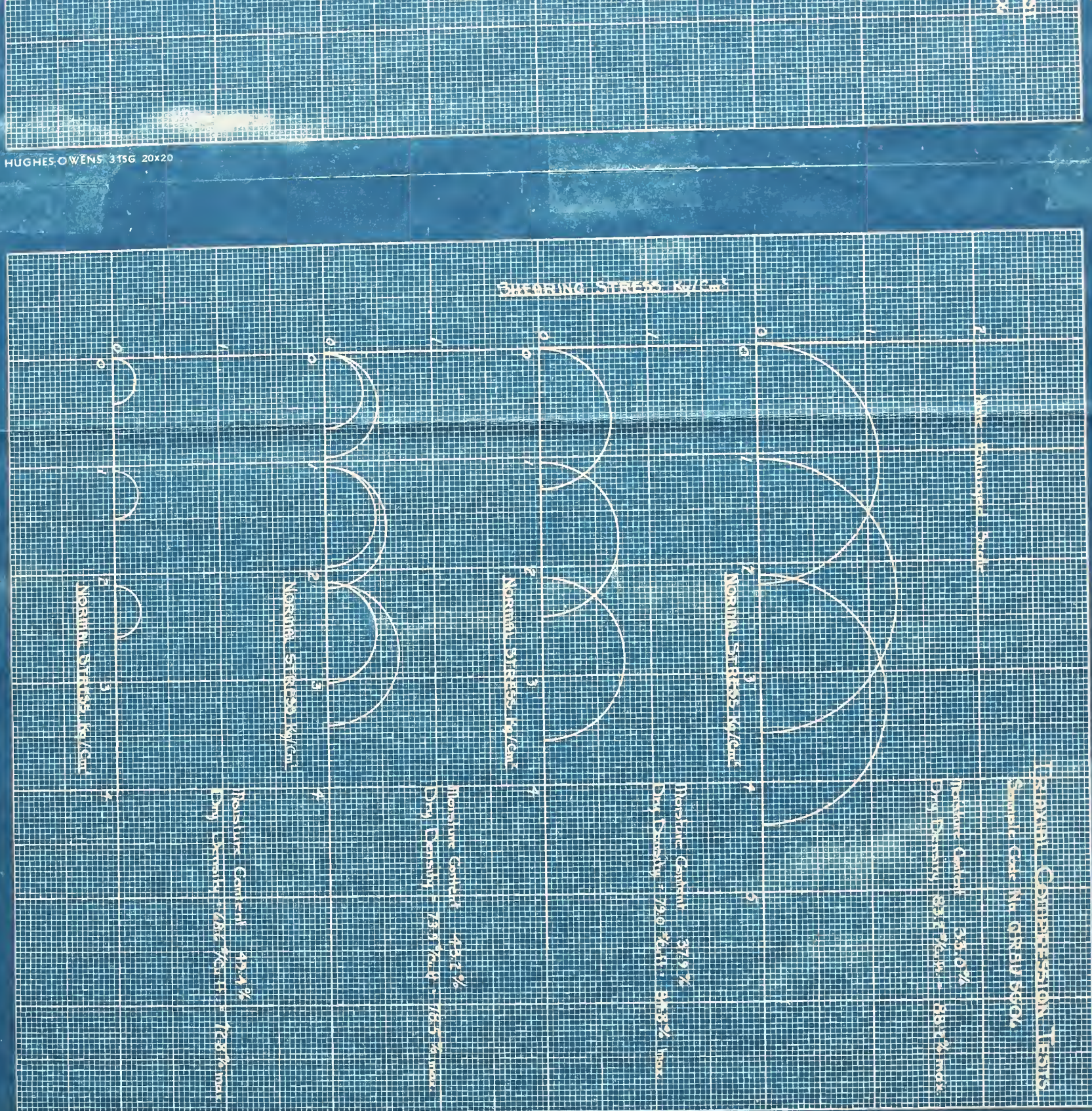
HUGHES OWENS 315G 20x20



HUGHES OWENS 315G 20x20



HUGHES OWENS 315G 20x20


SHEARING STRESS Kg/Cm²
NORMAL STRESS Kg/Cm²
Plastic Centre
Dry Density 1.720 Pcf.
Optimum Content 4.0 %
Plastic Centre
Dry Density 1.720 Pcf.
Optimum Content 4.0 %
Plastic Centre
Dry Density 1.720 Pcf.
Optimum Content 3.75

B29753